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BULLETIN III FEBRUARY 1922

REPORT OF THE SECOND ANNUAL MEETING

OF

THE AMERICAN ASSOCIATION OF SOIL SURVEY WORKERS

HELD IN

AGRICULTURAL HALL,

MICHIGAN AGRICULTURAL COLLEGE,

EAST LANSING, MICHIGAN

November 18-19, 1921.

Report Issued From The Office Of The Secretary,
Department Of Soils, U. of W. Madison, Wisconsin.
February 1922.

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ACKNOWLEDGMENTS

The Association is deeply indebted to Professor M. M. McCool, and his associates, through whose kind offices we were extended the use of a room in Agricultural Hall, Michigan Agricultural College, for holding our Second Annual Meeting.

All those in attendance have reason to be especially grateful for the splendid banquet which was served through the kind and generous hospitality of the members of the Soil Department of the Agricultural College.

The preparation of this report has been made possible only through the generous co-operation of those who presented papers, gave talks, and took part in the discussions at the meeting. Since not all subjects were covered by previously prepared papers, it was necessary to ask those not giving papers to send in a review of the talk given, and the discussion which followed. The response was unanimous, and has made possible a report covering every subject which was listed on the program.

The Association also wishes to acknowledge the helpful co-operation of the United States Bureau of Soils, through which office all the stencils for this report were cut, and of the College of Agriculture, University of Wisconsin, in whose mailing room the mimeograph work was run off, and a mailing list prepared.

The Soil Survey Conference was opened by Professor M. F. Miller, President of the Association, presiding. Dean Robert S. Shaw, acting President of the Agricultural College, opened the conference by giving an address welcoming the Association. A report of the conference follows.

W. J. Geib, Secretary.

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REPORT OF COMMITTEE ON SOIL COLOR STANDARDS.

J. Gladden Hutton, In Charge of South Dakota Soil Survey.

When your committeeman suggested at the Chicago meeting in November 1920 that some steps might be taken to standardize color descriptions of soils he did not anticipate that he might find himself submerged in the ocean of color that seems to lie all about us both in the world of phenomena and the world of literature. It seemed then a comparatively easy matter to have some constituted authority decide upon color names and to have such colors reproduced in a convenient form for the use of soil investigators. He is aware of the fact that such a color scheme must include soils from many areas having different mineralogical and organic content, existing under varying conditions of temperature and rainfall, and occupying different positions in the cycle of soil development. He is aware of the fact that such a color scheme must be formulated by soil scientists who have access to soils from many areas.

It was suggested at the Chicago meeting that Ridgway's color standards and nomenclature might be used as a standard. Mr. Thomas D. Rice of the Bureau of Soils wrote me on March 15th that he had examined a large number of soils in the files of the Bureau and with Mr. Rice's permission I shall read from his letter:

> "Since the discussion with you at Chicago, I have made some investigations of soil colors and some of the observations may be of interest to you. Ridgway's book was used as a standard, since it is by far the best publication we have found. This Bureau made efforts several years before Ridgway's book came out to get up a color scheme for soils, but the common color names being so at variance with the technical names and no satisfactory permanent color standards having been established, it was thought better to make up sets of soils to represent the common color names. The task of matching book colors is made much easier by Ridgway's large list. It is a matter of great difficulty, however, as you have no doubt found, to compare soils with printed colors. Light is not reflected with the same color values from soils, particularly cloddy soils, as from the printed paper. This is true of many substances, for example, metals have a color or lustre of their own. We may, however, be able by practice to make allowances and attain a greater skill in comparison. Before soils are compared with standard colors we must decide what state the soil to be compared should have. It is agreed by all that the official color must be based upon the air dried sample. A finely powdered soil may have a shade different from the cloddy soil, or even a smoothly cut soil section. In order to match at all, it is necessary to get a certain fineness, but in order to determine the field color it can not be pulverized too much.
>
> "Still, I am hopeful that we shall get out some useful standards. The time has come when we can not depend upon the memory of the field man to compare a soil with one he saw last year in another area. Our color distinctions are getting too fine for that and we ought to be able to make comparisons rapidly and accurately.

"I have had the opportunity in our soil room to look at a great many series and compare these with Ridgway's colors. Nearly all the soils commonly designated as red are really brown, such as chestnut, auburn, and burnt sienna, according to Ridgway's nomenclature. Very few are really red. The reddest soil I could find was the subsoil of the Greenville clay loam from Alabama, and it registered between garnet brown and Morocco red. Most of our soils come nearer the official drab than any other established color, but when a number of these are compared with each other there is quite a variation. Many gray soils range around smoke gray, but here too there is a wide range in soil shades between these and the next color. The Pierre series in your state has a wide range as shown by our samples; the shades occurring are light grayish olive, light brownish olive, buffy olive, deep olive, dark olive, drab gray, and several others.

"It is plain, of course, that we can not use the standard color names since they vary so greatly from common usage. Names such as avellaneous or burnt umber would not mean much to the public. We could use these names among ourselves, or, as you suggested at the meeting, substitute a number for each color. These technical color names could also be put in parentheses in the reports after the common color names.

"I find that of the 1115 colors in Ridgway's tables less than 400 are possible soil colors. A great many of these are very rarely found and in most cases could not be considered colors of true soils as, for example, bright colors of partly weathered rocks. It is possible to get up a list of 250 colors that will cover the range of true soils, and I believe that 100 colors might be selected that would serve all practical purposes. I have found about 60 colors in the soils we have examined. If we could get these colors printed at a reasonable price and put in a form for use in the field, it might prove very useful. Dr. Marbut is looking into the possibility of getting these colors from A. Hoen & Co., of Baltimore, who published Ridgway's book. If we can get them we must devise some convenient holder for field and laboratory use.

"Have you any suggestions thought out by this time on this subject? We are glad you brought up the matter at the meeting, as some scientific system of nomenclature for soil colors is becoming very necessary".

A second letter from Mr. Rice under date of April 15th stated that the Bureau had taken up the matter of color reproduction with Mr. A. B. Hoen of Baltimore. But a subsequent conversation with Mr. Rice did not seem to indicate that the color chart could be speedily secured. In view of this fact, your committeeman endeavored to evolve an other plan which could be put into operation, if so desired, with a minimum of expense and delay.

It is suggested that the color wheel, familiar to all students of elementary physics, be equipped with standard color discs and that the combinations of colors be used to match the colors of the soils. A compact form

of this well known device is exhibited here and for the sake of convenience is termed a chromometer or color measurer. Soil colors may be duplicated by using combinations of colors with black and white. A sample of the soil to be described is placed near the disc and by the trial and error method a combination is found which will match the color of the soil. A graduated disc makes it possible to read the percentages of each color employed in duplicating a given soil color. The percentages of each color may then be recorded and reproduced on a similar color wheel or chromometer wherever desired. The one thing necessary is that a duplicate set of color discs shall be available. It may be seen that no attempt is made here to name colors but the device will make it possible to secure an accurate record of the color factors involved. Such a record is, of course, not practicable save where investigators are concerned.

That such a method may be reliable it is necessary that standard color discs equivalent to certain wave lengths of the solar spectrum be available. The question of securing such standard discs was taken up with the Bureau of Standards at Washington, D. C., but the Bureau was not in a position to undertake this work at present. The discs used on the chromometer are the Maxwell disc s furnished by scientific supply houses and are here used only for illustrative purposes.

Certain other standard factors must be employed if accuracy is to be attained. The illumination of the apparatus must be the same at all times. Probably the north light untinted by walls or vegetation should be employed and the light should not pass through glass as color values are changed by most kinds of window glass. This fact we have all observed while noting the color of the road as viewed through the wind shield of an automobile and comparing it with the observed color when no wind shield intervenes.

The condition of the soil as to moisture content and pulverization must also be agreed upon. Finely pulverized soil smoothed with a spatula will probably most closely approach the surface of the discs in the manner in which it reflects light. This does not, of course, agree with suggestions made by field men, but it might appear that if all soils were reduced to this condition the factors involved would be uniform. The color factors of soil in a moist condition, and in a cloddy condition, for the heavier types, might also be recorded.

When the records are made it may be possible for some competent student to sit down in a laboratory with a chromometer and evolve a system of color nomenclature adapted to soils. The color factors may be tabulated for each color and these may be reproduced by the chromometer. A few discs only are necessary, and these may be replaced by new ones at a moderate price. This would eliminate costly reproduction.

It may be said that Ridgway records that system of numbers and mechanical devices did not appeal to many of his correspondents as did color names. In the absence of definite color charts it appears that the factorial system here suggested may be far better than nothing.

It should be said that owing to the fact that standard discs are not available, your committeeman has spent little time in attempting to formulate definite suggestions for the use of the discs used on this experimental device.

Before concluding this part of the report, it should be stated that Dr. Marbut, In Charge of Soil Survey, Bureau of Soils, extended a cordial invitation to your committeeman to come to Washington and placed the files of the Bureau at his disposal for this work. Routine duties, however, made it impossible to accept the invitation.

-oOo-

Mr. B. H. Hendrickson, Scientist in Soil Survey, Bureau of Soils, has submitted the following for consideration:

> "Working toward improvement in our present system of discerning true soil colors and tints, in the field, I have originated and used for the past six months a small, compact soil color chart adapted particularly for field use, consisting of soils of true solid or compound colors, mounted with glue and oven-dried on white paper.
>
> "Messrs. M. H. Lapham, and H.H.Bennett, Inspectors of the Bureau of Soils, have both given me some encouragement, and Dr. D. S. Jennings of Utah thought well of it, and is getting up a set along similar lines. I will be glad to send to you a description of method used, and some duplicates of my prepared samples.
>
> "The efficacy of this system is largely dependent upon comparison of colors in the air-dry condition, and has its limitations on that account. However, official recognition is given to soil color comparisons when made only in the air-dry state. While soil colors are sometimes described in a moist condition, I can hardly conceive of the weather conditions being so humid during an entire soil survey season in any locality as to preclude an air-dry comparison for the upper soil horizons, at least. I hope you will agree on this point, and emphasize it at the convention.
>
> "I will be greatly interested in your findings, and will welcome any suggestions you may offer. Mr. Carter, of the Texas Soil Survey, will bring to Madison my little exhibit."

A SOIL COLOR CHART ADAPTED TO FIELD USE.

By
B.H.Hendrickson, Scientist in Soil
Survey, Bureau of Soils, U.S.
Dept. of Agriculture.

This soil color chart method of field comparison and determination of soil colors consists essentially of a number of small soil samples mounted on a white paper background, with common glue used as the adhesive material, and oven-dried immediately after mounting in order to prevent change of color due to hydration. Assembled in a folder or notebook, after having been carefully named as to color,

they provide a convenient color comparison with air-dry soils met with in the field.

This method was devised as a possible means of overcoming in some measure, the difficulty of accurately determining soil colors in the field. Change of color vision of the individual field man, from day to day, as well as the variation between soil color concepts of different individuals, have long been recognized as troublesome sources of error. Similar inaccuracy due to inexperience on the part of new men in the Soil Survey can be largely obviated by use of the color chart.

In preparing the chart, small samples of soil were sifted through cheesecloth or gauze to remove lumps and foreign matter. Strong white paper was prepared by coating with Lepage's glue, diluted with water in the proportions of 1:1, 1:2, 1:3, and 1:4, by volume, depending upon color of sample to be mounted. Thinly diluted adhesive material has proven best for the lighter colored samples, and thicker dilutions for the darker ones. The sifted soil material is sprinkled over the glue-coated paper, the excess shaken off, and the sample at once oven-dried for five to ten minutes at a temperature just below the point at which the paper will discolor. The samples are then carefully compared, named, and pasted in a cardboard frame in such a way as to prevent friction between samples. They are then arranged alphabetically, or in some other convenient manner, and bound together in a folder or notebook, and are then ready for use.

Soil colors are compared in the field by placing a pinch of air-dry soil directly on the mounted samples, until a close color comparison is noted. With a little experience in the use of the chart, very nearly accurate color distinctions can be discerned quickly.

Among its advantages might be mentioned the fact that regardless of the apparent color-changing effect of the slanting rays of the early morning or late afternoon sun, the chart will give the true color. The same is true in any light. Its use will also prevent any great variation in the color descriptions, by different persons, of a soil series of known color range, occurring in widely separated parts of the country. It will also assist in studies of the color-moisture relation in soils. The method is exceedingly simple, and a useful chart can be easily prepared by any field man, to cover the range of soil colors in any particular area.

Among the disadvantages, the outstanding limitation consists of the well known difficulty of comparison between any air-dry sample, and the commonly encountered moist soil conditions met with in the field in soil survey work, particularly in humid sections. Considerable difficulty was experienced in getting the finished samples to exhibit the identical color of the original soil sample. Some of the compound colors, those combining red and brown tints in particular, have a tendency to become a shade or two darker in tho chart samples. It should be noted, however, that if correctly named, these altered samples are just as useful for color comparison purposos.

This suggestion of Mr. Hendrickson is of great practical interest. The question as to how generally it may be applied may arise. For a definite area,

at least, it has many points to recommend it.

-oOo-

The following letter indicates the general interest in the matter of color standards:

Gwalior, India.
April 19, 1921.

Mr. J. G. Hutton,
S. D. Experiment Station,
Brookings, S. D., U. S. A.

Dear Sir:-

I was much interested in your letter regarding soil color standards in the February 18th number of Science. I assure you that there have been many of us who have been much in need of color standards for soils work in the field. During my soil survey field work experience I was very strongly impressed by the need, for I found that some of the men that I worked with saw a predominance of a certain color in a soil, and I would not see that color, but another one.

I have discussed the matter with Mr. Macy H. Lapham, Inspector of the Western Division of the Bureau of Soils survey work, and with other old soil survey men. They tell me of various efforts along the line of standards, where water colors were made up and where other colored substances were taken as a basis. But none of the schemes were a success.

Since coming to India I have been doing some soil mapping along the lines of the work by the Bureau of Soils, and as I am able to do only a little work at odd times, I find it very difficult to keep the colors in mind from one time to the next. Some satisfactory means of obtaining satisfactory color standards would be a great help.

It has occurred that perhaps a tint photometer of the Hess-Yves type would be the thing most suited to the work, but to be entirely satisfactory it would have to be adapted to use it to determine field color as well as the color of a small sample.

Of course, one comes back to the main question as to what is the value of color? The Bureau of Soils has been making very fine distinctions in color, or has been attempting to, on the supposition that color was intimately connected with some other properties of the soils. But as far as I know the signigicance of small color variations has yet to be determined. Of course there are certain colors of soils that are associated with very definite properties, and about this there is no doubt.

Personally, in my work here, I am endeavoring to map as fine variations as possible, going on the usual supposition of the Bureau that it is easier to map variations in the field, and then combine, if necessary, than to subsequently [illegible], it [illegible] to recommend it.

-o0o-

The following letter indicates the general interest in the rating of color standards.

Dhulia, India.
April 9, 1934.

Mr. A. L. Smith,
U. S. [illegible] Station,
[illegible]

Dear Sir:

I was much interested in your letter regarding soil color standards in the February 1934 number of [illegible]. I [illegible] you that there have been some of us who have been much in need of color standards for [illegible] work in the field. [illegible] field work [illegible]. I was very [illegible] impressed by the [illegible], for I found that some of the [illegible] I [illegible] of a [illegible] color in a soil, and I could not see that color, for [illegible].

I have discussed the matter with Mr. [illegible], Inspector of the Eastern Division of the [illegible] of India [illegible], and with other [illegible] survey men. They tell me of [illegible] about the [illegible], where water colors were made up and [illegible] to a basis, [illegible] of the colored [illegible] a [illegible].

Since coming to India I have [illegible] the [illegible] of the work of the Survey of India, and as I [illegible], I find it very difficult to [illegible] the colors [illegible]. Some satisfactory means of obtaining satisfactory color standards would be a great help.

It has occurred [illegible] a [illegible] photographs of the [illegible] would be the [illegible] to the work, but [illegible] would have to be [illegible] field [illegible] as well as the color of a small sample.

Of course, one comes back to the [illegible] of what is the value of colors? The [illegible] of [illegible] from [illegible], [illegible] on the [illegible] that [illegible] with some [illegible] properties of the [illegible]. But so far as I [illegible] small color [illegible]. Of course [illegible] with [illegible] is of [illegible].

[illegible], I am [illegible] as possible, [illegible] on the [illegible] composition of the [illegible] variations in the field, and then [illegible] separate soils originally mapped as one sort.

I hope that I may have your views at length on the subject, as for a number of years I have been very much interested in the matter.

I am

Yours very truly,

ROBERT L. PENDLETON.

A FEW SUGGESTIONS ON SOIL COLOR AND THE NEED OF STANDARDS IN MAPPING.

By A.M.O'Neal,Jr., Iowa Soil Survey.

The Soilist in his work of classifying and mapping soils is constantly confronted with color problems that are difficult to solve, and are a constant source of worry. The descriptions as furnished by the U.S.Bureau of Soils are excellent, but in the interpretation of these by the various field men is the difficulty. Different men interpret colors differently, so a soil that appears yellowish brown to one may look different to another. The Tama series is described as having dark brown to black soils and yellowish brown to light brown subsoils; the Clinton series as having gray to dark gray soils underlain by light brown to yellowish brown subsoils; and the Ruston as having brown to grayish brown soils and yellowish red or reddish yellow subsoils. Will different men recognize and map these soils alike without a uniform sample with which to compare their findings?

Along county boundaries I have often had occasion to observe different mens ideas of the same soil type, and found that their interpretation of soil color is often quite different. It is difficult to hold a type true to color no matter how conscientious the field man. His ideas may change as the work progresses with nothing but a soil description, which he carries in his mind, to check against.

Realizing these difficulties I undertook the study of a number of soils collected from different parts of Iowa, to see if a definite relationship existed between types as mapped in the same or different localities. These soils were compared not only with each other but with the color descriptions as furnished by the various field men in their reports. It was found that though these descriptions were identical the actual sample showed marked variations in many cases. Further it was noted in a few cases that even though the actual samples were similar the color descriptions, as given by different field men, were unlike.

Moisture influences soil color and the field man must carefully consider this factor in mapping. A soil after a rain will look different from what it does during a dry spell of weather. Just how much effect moisture has on color has not been determined, but it should be worked out for use by the field man.

Since different men interpret color descriptions differently it would seem that more uniform work could be done and the chance of error reduced to a minimum if color standards were prepared for general use in the field. A large amount of soil work has already been done in various parts of the country and these standards should only be prepared after collecting and comparing a large number of samples of each series and type. In this way the most typical can be decided upon. However when once selected all future work can be compared and held close to these standards. When new series and types are established the color of soil and subsoil can be decided upon at the beginning. Since soil types will always show a certain amount of color variation it would seem well not only to give the typical but also the two extremes. Further it would be a great help in mapping to show, if possible, the effect of moisture on color. Color plates might be made showing the color

after a certain amount of moisture had been added.

The color standards should preferably be in the form of charts giving the color of the 3 foot soil section. These charts could be prepared for each type and furnished to the men. They should be in loose leaf form and small enough to be carried in the pocket. The field man after a few trips over his county knows about the soils he may expect. He can therefore select the plates needed without carrying the entire number.

Soil colors are difficult to reproduce, and this probably has discouraged work along this line. However since the publication of Mr. Ridgways book on Color Standards and Nomenclature the problem has been simplified and it is hoped a system of soil color standards can be worked out and perfected. The writer feels that through such a system the status of the soil work throughout the country can be greatly improved.

REPORT OF COMMITTEE ON INFORMATION AND PUBLICITY.

By M. F. Miller, Prof. of Soils,

University of Missouri, Chairman.

At the last meeting of this association the committee on information and publicity and the committee on utilization were charged with the responsibility of preparing a statement of the value of the soil survey to be supplied to the various colleges. After considerable correspondence it was decided to prepare a statement to be issued in the form of a small booklet. The idea in preparing this material was to present facts which would be of use before legislative committees having to do with soil survey appropriations in the various states. By the help of the Secretary of the Association and others, this material was prepared and the booklet issued in such quantities as to leave a considerable reserve for distribution in future years.

The chairman of this committee has also had correspondence with practically every man in charge of soil survey work in the states with reference to means of popularizing the work of the survey. An attempt has been made to encourage the use of existing state agencies for this purpose and in this connection it might be well to enumerate some of the things that have been brought to the attention of the various states.

The county agent is probably the most effective means of educating the farmer in the use of the soil survey. Unfortunately, many county agents are not very familiar with soil survey work. In such cases, it has been suggested that group meetings of county agents might be held for the purpose of giving them definite instruction particularly in the use of maps and reports. Some states have already done considerable along this line. Some are sending their soils extension specialists among the county agents to give them information. One state is proposing to give definite instruction in the use of the soil survey maps during the annual conference of county agents at the college. Another is sending representatives of the soil survey staff to the various counties where maps are available for the purpose of instructing the county agent regarding the soils of the county. It seems highly important that some such steps be taken in all states where soil mapping is being done.

Next to the county agents, the soils extension specialists of the college, are probably the most important of the available agencies for familiarizing the farmers with the work of the soil survey. As in the case of the county agents, however, some of these men are not well versed in soil survey methods. It seems very important that efforts be made to secure soil specialists who have had some soil survey experience or who will familiarize themselves with the work. It is also desirable that soil demonstrations which are laid out by these men be organized by soil types so as to give the results a definite application. This is particularly true of the prairie states where soil types are less numerous than in many other regions.

Probably the greatest opportunity for newspaper publicity is through the weekly news service of the colleges. Most colleges are maintaining such a news service at this time and where the soil survey men will make it a point to keep the news service supplied with short items, particularly during the winter

months when they are not in the field, a considerable amount of publicity may be secured. The standard agricultural papers will also make use of occasional feature stories having to do with the work of the soil survey. Where these articles carry one or two illustrations they will be widely read.

More attention should be given to the instruction of students in the Colleges of Agriculture in the use of soil survey maps and reports. While it is impossible to introduce any large amount of actual field work in the regular courses in soils, the students will secure much information through practicums having to do with the soil maps and with the identification of a few soil types in the field. The correspondence with the various colleges indicates that quite a number of states are already using such practicums and practically all seem favorable to the plan.

Other means of popularizing the work of the soil survey might be mentioned, which apply to only a part of the states. For instance, some of those states which are publishing their own maps have adopted the policy of issuing county soil survey posters. These posters carry the map, together with considerable information regarding the character, utilization, and soil management of the various soil types. They are supplied to schools, banks, newspapers and realty men and serve to attract the attention of many who do not receive the regular report.

In those institutions where short winter courses are given the attention of these students may well be called to the work of the soil survey and some definite practicums organized to train them in the use of the maps. Short course students are always interested in things of practical value and there should be no trouble in interesting them in the work of the soil survey, particularly where maps of their home counties are available.

Some colleges are making use of the maps in the courses in farm management. Farm management problems are assigned for different soil types and the students are required to make use of the soil maps and reports in preparing the papers.

Finally, the introduction of agriculture into the country schools makes it possible to interest many teachers in the survey. While it is true that they will be able to make little use of the maps and reports in their teaching, they will certainly find the maps of their own home counties of interest and many pupils will learn that such an organization as the soil survey is in existence.

At the last meeting of this association it was suggested that an effort should be made to secure the publication of two or three popular articles on the soil survey in one or more of the leading magazines, such as the Independent, Popular Science Monthly or such prominent agricultural publications as the Country Gentlemen or Farm and Fireside. The chairman of this committee has been endeavoring to interest some of our workers in the preparation of such articles but thus far none have appeared. Two men have virtually agreed to prepare such articles and it is hoped that these will appear in the near future.

An opportunity which should not be overlooked by the colleges is that of publishing short popular circulars having to do with the work of the soil survey. Such circulars should contain material somewhat similar to that published in the

small pamphlet issued by this association on the utilization of the soil survey. It should contain pointed facts regarding the progress and uses of the soil survey in the individual state and be illustrated with appropriate cuts. This circular should be sent to county agents, schools, vocational teachers, bankers, legislators and farmers.

There is little doubt that the work of the soil survey is not receiving sufficient attention, particularly from the public. Most people have either not heard of it or have only a very indefinite idea regarding its purposes. It should be the duty of such an organization as this to find means of keeping the matter before the public.

THE PROBLEMS OF THE FIELD MAN.

Need of Soil Definition.

By H. H. Krusekopf, Prof. of Soils,
University of Missouri.*

The problems of the soil survey field man are proportional to the lack of knowledge of soils. In soil surveying as in any other field of endeavor where we deal with natural objects, the more we know about these objects the fewer problems offered in studying and classifying them. The field study of soils, as a separate science, is a comparatively recent development. It is a science that has come into being largely through soil survey work, but the art of soil mapping is as yet far from perfection. The reason is obvious. Our field knowledge of soils is as yet too limited, in spite of the great progress that has been made in recent years.

The criteria by which soil units are separated, identified and described are not as yet clearly defined. In fact, the soil survey work has not been properly understood or appreciated because the factors which are used in the classification of soils have never been accurately stated. Different factors are given varying prominence by different surveyors, and the separation of soils is often not upon parallel lines or lines of equal significance, Origin, mode of formation, color, physical properties are some of the factors variously stressed by different workers. There is yet, too much vagueness in the minds of most soil men as to what characteristics or peculiarities should be considered in recognizing soil differences. Textural differences have been well defined and are easily determined. In fact some of the separations which are now being made have been carried to such a degree of fineness that there is very little, if any, appreciable agricultural differences between some of the classes. (ex. sandy loam, vs. loamy sand).

But how about such characteristics as color, arrangement of soil horizons, structure of soil material (compaction, porosity, etc.) and the segregation of iron? To these characteristics no such exact divisions or limitations have been applied as to the textural, although they are of equal and even greater importance in soil differentiation. It should be agreed that the structure of the soil is of more importance than color in soil differentiation. Color is influenced more or less by local conditions but the structure of the soil is an expression of the cumulative effects of all the agencies of weathering. In general, each horizon of the soil profile should have a thickness of at least three inches before it is recognized as a soil characteristic for differentiation. Soils with imperfectly developed horizons should be distinguished from those that show distinct stratification. Compaction is a characteristic that must be held distinct from permeability in soil identification. In all soil grouping any variation in the number, texture, color, arrangement and compaction of the different horizons must be considered a soil difference. Mottling as a characteristic in soil definition has received varying degrees of attention.

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* In the absence of the author this paper was read by Mr. H. G. Lewis of the U. S. Bureau of Soils.

These and many other factors must be clearly defined and arranged as to their relative importance for soil identification. In the present system of soil mapping a standard as to color and the various physical properties has been adopted for each soil unit or more particularly for each soil series. A comparison of this standard to the soil unit as mapped, frequently shows a wide variation. It is to be expected that the ideal of a type as held by one man will not always be identical with that of another surveyor. Also, because of the variability of soils, a certain range of variation must be allowed for each soil unit, but such variations should not be fundamental soil differences. (Ex. in loess region all black soils sometimes called Marshall, although subsoil varies from friable brown silt loam to compact, stiff gray clay.) New men in particular, and even experienced men when working in new territory, generally have difficulty in determining the factors (aside from texture) that should be recognized as giving rise to soil differences. There is as yet a lack of uniformity of conception as to color and the relative importance of structure. The relation of these characteristics to topography, drainage, and chemical composition must be better understood. To attain this end, greater consideration must be given to studying the soil as it is----its profile, its structure.

In the soil mapping of the past, the identification and grouping of soils was considered mainly from the viewpoint of forces that have acted to develop the soil rather than from the viewpoint of actual differences in soil itself. Thus we now speak of glacial soils, loessial soils, etc., and consider each group distinct from the other, although, each may have soils that are practically alike in all physical and agricultural characteristics. There is need of a clearer defining of characteristics that give rise to soils differences. With greater and more definite knowledge of these factors the soil survey men will have less trouble in identifying and establishing the various soil types and soil series, and what is of more importance, the soil mapping will be done on a more consistent and uniform basis.

Personal Problems.

The soil survey is a comparatively young institution with a relatively small number of workers. This condition is largely responsible for the small number of experienced men who must act as instructors. (The majority of new men are left to absorb the method of soil mapping from contact with the older men in the Bureau). The nature of the field work is so rigorous that it appeals primarily to young men, and few reach middle age before having abandoned soil surveying for less strenous or more remunerative labors. Many take up soil surveying for the opportunities of travel it affords, and are not vitally interested in the work itself. All this has resulted in a rapid turnover of workers, so that there are few old men, but many new ones, and this at a time when soil surveying is in its formative stage.

The result has been that many of the soil surveyors have never received adequate training. It is the opinion of the writer that rarely does a new man do reliable and accurate work without at least two years of experience. The inadequacy of old men to train the beginners has resulted in much poor work, and in many cases delayed the attainment of efficient mapping by the beginner. It may not be possible for soil survey organizations to give preliminary training to new men before sending them to do field work. But greater effort should

be made to place the new man with experienced men for two or more seasons. Moreover, only such of the older men should be selected as leaders that are recognized for their careful work and for their willingness to make an effort to impart their knowledge to the beginner. It should also be the function of the Soils Departments in the Agricultural Colleges to train men for soil survey service.

It is unfortunately true that beginning soil survey men have not always received good training. The ideals of the new man are formed from the man in charge of the party. If the latter does careless work, knows little about soils, or over emphasizes features that are of minor importance in soil mapping, the chances are that the new man will adopt similar methods and may never outgrow them. For example, in the survey of a certain Missouri county the party consisted of an experienced Bureau man, and a state man, a beginner. It was the opinion of the older man that a spotted map,--one that showed many small and irregular areas,--was indicative of accurate and detailed work. The soils in the county are rather uniform over large areas, i.e. the same type frequently covers several square miles. Moreover, the region is largely undeveloped and cannot be traversed in detail. The soil map would indicate that the soils of the county are very complex, that there are many small variations and that these are most numerous near the roads. It is obvious that with such training the new man got some very erronious ideas as to soil mapping. Fortunately, he was a bright fellow and within a year or two overcame his early handicap and developed into a good soil surveyor.

Another party, also in Missouri, did much of the soil mapping in their room. The forenoons usually were spent going over a section of country, but the mapping, i.e. the platting of the soils, was done after they got home. A good memory is essential to a soil surveyor, and no doubt these men had it, but an examination of the soil map shows that in a number of instances their memory failed them.

There is a tendency that is all too common among many field men to give too much attention to the merely mechanical part of soil mapping and too little time and thought to studying the soils. In the majority of areas surveyed it is necessary to construct a base map. In order to have an accurate base map, the traverse work must be done carefully. The desire to have good closures particularly in long traverses, frequently takes so much of the surveyor's interest that he gives little attention to the mapping of soils. He loses sight of the primary object. In effect he is a cartagrapher rather than a soil surveyor. (For example, a field man in Missouri made a traverse approximately 20 miles in length--at the same time mapping the soils. In traversing the last 2 or 3 miles he became so interested in having a good closure, that he failed to make a single soil examination and only indicated such soil boundaries as were due to topographic differences.) Others study the map more than the soils. The desire to construct an attractive map is frequently at a sacrifice of accurate soil mapping. These tendencies could be overcome in part if the field men were supplied with accurate base maps so that all their attention could be given to the mapping of the soils. Base maps must be accurate, otherwise they are useless. The newer topographic sheets generally are very satisfactory.

Relation of the Soil Survey Organization to the Field Man.

The nature of soil survey work requires that the field men are widely

scattered in small groups or pairs. They are not closely connected to the central organization, and they stand alone in a field of activity that is not always understood or appreciated. They are denied the stimulating influence that comes with association of fellow-workers, and their work is not under sufficiently careful survelliance of the organization that employs them. These conditions, to a very large measure unavoidable, have a tendency to lessen the enthusiasm and loyalty of the field men for their work. Soil surveyors as a class have shown a professional devotion that in many respects is remarkable. The majority of field men feel, however, that their relation to the central organization is too impersonal. Greater enthusiasm would be inspired if occasional comments were made on their work--good work commended and poor work criticised. More frequent visits by inspectors and others engaged in soils work is suggested. This would promote a better esprit de corps.

With greater enthusiasm there will come a deeper interest in soil study. Soil surveyors feel that they have not yet been taken into the confidence of Experiment Station workers. They feel that their effort is not looked upon as being of equal importance or as scientific as that of the laboratory worker. I think we should insist that the field study of soil is as scientific as that of laboratory studies. A recognition of this fact is essential to the development of soil science. There is need of a more "scientific spirit" among field men, and this spirit should be encouraged by the soil survey organizations. When such a spirit exists, it is inevitable that good soil mapping will be done.

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With greater emphasis [illegible] soil survey. Soil surveyors feel that they have not yet been taken into the confidence of [illegible]. They feel that their efforts do not [illegible] as being of equal importance or as valuable as those of the laboratory workers. I think we should [illegible] that the field [illegible] as scientific as those of laboratory studies. [illegible] is essential to the development of soil science. [illegible] field men, and their spirit should be encouraged by the soil survey organization. Then with a [illegible], it is [illegible] that good soil mapping will be done.

THE FIELD MAN'S GREATEST PROBLEMS.

By A.E.Taylor, Scientist in U. S. Bureau of Soils.

The work of the field man lies largely in the preparation of a map, showing the location of the various soils in a given area, and a report describing these soils.

It is particularly desired that a detailed map and report of an area will give to the reader a comprehensive and clear description of the soil conditions for each forty acre tract. To produce a map of this quality it is necessary that the field man should come in close contact with the soil, preferably walk over it, in order that he can be reasonably certain as to its character on practically every acre. The distance between foot trips should be governed by the frequency of soil changes. Where soils run rather uniform one might walk across the area about every quarter of a mile, but where they are very changeable it would be better to cross the area about every forty rods and do much zigzaging so as to be sure of the location of soil boundaries. Accuracy of location is an absolute necessity in mapping the boundaries between soil types.

Coming in contact with all of the soils of an area would be useless unless the field man recognizes differences in the character of the soil material. He should study, most assiduously, many soil sections, making his observations as searching and exhaustive as is possible for him under the circumstances. Because of a failure to observe important differences in the soil sections, it has, in cases, required more work to revise than to do the mapping in the first place. For instance silt loam soils having lower subsoils ranging from rather friable silt loams to hard, compact silty clay loams have been mapped as the same type. Farmers knew there was considerable difference in the agricultural value of these soils, and many of them, if asked, would have pointed out the difference in the lower subsoils.

Field men should make inquiries of the county agents and better farmers as to their soil difficulties. Sometimes a satisfactory solution is unknown. The difficulty may be of a nature that the field man by a comparative study of soil sections in relation to productiveness, a study of the various methods or experiments already tried out or by other lines of investigation, might throw new light upon the solution.

Good soil mapping is always characterized by consistency. Inconsistency in mapping labels work as unreliable. It is a good habit for a field man to frequently revisit different parts of the area he is mapping to be sure that he is consistent with himself in the determination of the color, texture, structure and topography variations. The more persons engaged in the mapping of a particular area the more complicated the problem of consistency becomes. The man in charge cannot exercise too much care in going over the work of the other members of the field party to see that the mapping is consistent. A very undersirable practice is where several additional men join in a field party for the last few weeks of a season to help finish the work. This always causes an inconsistency in the mapping, because men who have not been working in the same area cannot possibly adjust themselves to a certain system of mapping within such a brief period. There is considerable difficulty in keeping the work consistent in adjacent counties. After the one county is completed usually some years elapse before another is started. Owing to changes in the nomenclature,

improved methods of mapping and a new field party a very marked inconsistency is sure to develop. If the field men in charge of the work in the various states would do more or less mapping in all the areas of their respective states, and would go out beyond the county lines for 2 or 3 miles and make a careful study of soil conditions they would often be able to discover what might be a very important soil type in some of the unmapped counties, but would have such a limited development in the county being mapped that, without this additional knowledge, it would be combined with some other type.

A mistake often made by field men is a failure to recognize properly a new soil condition. Rather than give it a number and map it separately it is tucked in with whatever type it seems to resemble most closely. Possibly a number of these soil differences, all worthy of recognition, are included with other types in mapping and not even as much as a note is taken to describe them. In consequence the soil map and report are incomplete and will in course of time need revision. A field man should map and describe carefully all soil types, phases and questionable phase differences occurring in his area. It is not his place to combine, but rather he should take up the matter of field combinations with the inspectors.

A question, that can be very profitably discussed at this meeting by field men, is how to carry on detailed and reconnoissance surveys most expeditiously under various road and topographic conditions? In this paper your attention is called to only one exceptional condition--where a morainic belt, 10 miles long and 4 miles wide had such an intermingling of soil types that on an average, eight distinct soil areas were shown on a 40 acre tract. Owing to the smallness of type occurrences it was found impossible to insert the type numbers in the area as indicated on the map, nor could these be indicated on the margins of the map on account of the great number of small areas. This difficulty was successfully overcome by the adoption of symbols to take the place of numbers. These symbols could be legibly inserted in a one acre space as indicated on a map, having a scale of one inch to the mile. The map never had to be oriented in order to read them. A particular symbol was used for a certain type for only one day at a time. This was done because the number of symbols was very limited and a certain type might be well represented in one locality and not at all in another. The blank was used for the type, which would likely be encountered in small areas most during the day, the period for the one of next most frequent occurrence, and then the multiplication sign, dash and radical for other small areas.

Means of transportation is an important problem. Today, a soil man is almost compelled to operate a car, and many times it might seem to him that the greatest problem of the field man is to keep the thing running. In one instance less than 20 minutes have been lost in the field for the last seven and one-half months on account of car trouble. The party, before beginning the season's work, engaged a first-class mechanic, who was trustworthy, to see that the Ford was in good condition. To avoid tire trouble five demountable rims, an equal number of first quality tires and an equal number of the best of inner tubes were used. Where one has to drive over unimproved roads they sometimes get stuck, and have to lose several hours in getting the necessary assistance to pull out. Under such circumstances a light fence stretcher, log chain, rope, sledge and three and one-half feet of two inch pipe for an anchor will enable one to pull the machine, even though it is resting on the axles in the mud, at the rate of one foot a minute. In well forested areas a tree can usually be

found to take the place of the pipe anchor.

When a man has finished his field work and is ready to write his report, he may find his notes lacking in fullness and incisiveness. The character of his report will be largely dependent upon the kind of notes he has taken. Those notes written while making the observation are by far the best. Notes are usually too general. The field man should ever strive in describing a soil section or any other phenomenon for accuracy. However, he should not contant himself with being a mere recorder. Much in a soil section is obscure. One should not only see what spontaneously arrests his attention, but he should draw out from what he observes inferences and interpretations to promote further observations. When these suggestions have arisen, the field man should seek out the phenomena that discriminate between them, and under such stimulus, phenomena that would otherwise escape his attention at once comes into view because his eye has been focused for them.

To summarize:- it is deemed important that a field man should understand thoroughly what it means to come in close contact with the soil while mapping, to make accurate observations of soil sections, to learn from farmers about their soil problems, to be consistent in mapping , to properly map and take notes on new soil conditions, to proceed most expeditiously in making maps under various road and topographic conditions, to handle a car in field work and to take good notes.

DISCUSSION OF THE FIELD MAN'S GREATEST PROBLEM.

By W. E. Tharp, Scientist in U. S. Bureau of Soils.

The field man's problems vary, necessarily, with the character of the area being surveyed, the conditions under which the work is being done, and in no small degree upon the individuality of the field man himself, but one question almost invariably arises: "How much detail shall I try to show".

We shall attempt no specific advice, or give any general recommendations for nothing along these lines would be essentially new to the field men assembled here. We will however venture a few suggestions which possibly may be helpful in some instances.

The Bureau's scheme of classification admits of a high degree of differentiation but, as we all know, it is impracticable to indicate all the soil variations easily recognizable in the field. The best of mapping consists essentially in grouping into types and phases the closely related ones. Some features must be given clear recognition, others more or less subordinated. Time, cost and human limitations must be taken into consideration. At this point the field man might ask, In what way can I make this survey best serve the agricultural interest in this particular area? What problems are arising with which some soil distinctions are, or seem to be, related? Are there not some features within the scope of my work which seem especially desirable to indicate?

In most of the older counties of the Northern States the use of lime, the increasing interest in commercial fertilizers, the adaptation of soils to particular strains or varieties of crops, and the necessity of conserving soil fertility on the thin or eroded lands, are out standing problems. If all the technical soil distinctions could be expressed all these agronomic problems, so far as soil surveys apply to them, would be provided for, but as previously mentioned this is not entirely practicable. But if it is possible to twist our field methods a little bit and thus make the map show more clearly some of the soil variations connected with these problems it seems desirable to do so, even if some technical distinctions have to be slighted.

The recognition of topographic phases seem desirable whenever they may express appreciable differences in land values. The careful delimitations of muck deposits, of permanent marshes, and of bodies of water, seem well worth while, As an official reference for non-resident land owners, investors, and financial institutions, the soil maps should show the boundaries of these features with as much accuracy as possible.

In the survey of undeveloped sections of the country a sort of moral responsibility rests upon the field man in his classification of the land. A detailed map carefully executed places him in the clear. This is not always practicable, but a separation of agricultural and non-agricultural lands as measured by present economic conditions should always be made. Here again the judgment of the field man as to land values should take precedence over his knowledge of soils. One of the first interests his report will probably serve is the highly important one of assisting people not previously acquainted with the regionin the selection of land for a farm home.

In conclusion it seems desirable to lean toward the so-called practical side of soil mapping whenever a choice must be made between this and the extreme of technical separation.

TO WHAT EXTENT DOES THE SOIL TYPE INDICATE AGRICULTURAL VALUE AND FERTILIZER REQUIREMENTS?

By R.S.Smith, Illinois Soil Survey.

As I understand it, the soils of an area are separated into types because it is thought that each type differentiated has certain characters of agricultural significance not common to the other types. Various characters or complex groups of characters determine a soil's agricultural value and its fertilizer requirements. Some of these characters are inherent in the soil itself, others are external to the soil and cannot be taken into consideration in establishing types unless they have acted sufficiently long to make their impress on the soil; that is, as Dr. Marbut insists, types are differentiated on the basis of soil character. To have real agricultural significance, these characters must determine, at least in part, agricultural value and fertilizer requirement. To tell a man that his farm, or the farm he contemplates buying is Tama silt loam or Brown silt loam conveys no real information to him unless at the same time he can be given a pretty clear statement regarding its agricultural value, and if the response of this particular land to various fertilizer treatments can be definitely stated, information of great value is being given.

Illinois has been engaged in the soil survey of the state for about twenty years. In addition to the comparatively large expenditure for soil mapping and publication of soil reports, about thirty-eight fields are now being conducted in various parts of the state, presumably for the purpose of determining the fertilizer requirements of the various soil types as mapped.

It is not my purpose to criticize the Illinois work, but to make this discussion worth while, I must point out very frankly what in my opinion we have accomplished and what we have yet to accomplish before our soil survey and its allied activities can yield the information we need.

First, let us consider the matter of agricultural value. For the purposes of the soil survey, Illinois is divided into 17 great subprovinces, and each subprovince, for the sake of convenience, is given a number. This division is based largely on Frank Leverett's glacial map of Illinois and was made because the soils of each subprovince have certain distinguishing characteristics of agricultural significance. The soils within each subprovince are separated into types, this separation being based largely on the color, texture, and structure of the strata to a depth of forty inches and on topography. I believe that it will be agreed that these characters are exceedingly important in determining agricultural value.

Let me illustrate this point by giving an example. Suppose that information is desired regarding the agricultural value of an upland prairie farm in southern Illinois, and we find that it is mapped as Gray silt loam on tight clay. We can state with confidence that this land has poor natural drainage, that no method has yet been discovered of underdraining it, that it is low in organic matter, and is strongly acid unless lime has been applied. In short, it is of comparatively low agricultural value. Just the price it should bring on the market cannot be stated, for that varies with many conditions entirely aside from the crop-producing power of the land. This is information of great value, particularly to prospective buyers, as is evidenced by the large number of requests

we get for this type of information, and by the constant use made of our soil maps by land banks, real estate agents, and others engaged in the buying and selling of real estate. I believe that the soil survey in Illinois and in all other states where the work is at all extensive, is effectively and efficiently meeting the call for this kind of information, for we not only give information regarding Illinois soils, but frequently have occasion to make use of the Bureau of Soils maps of areas in other states for the same purpose.

While we believe that the information the soil survey furnishes regarding agricultural value is authentic and highly worth while, it must not be forgotten that the soils mapped under a given type name vary somewhat in crop producing power. It is a hopeless task to map soils in sufficient detail to warrant the statement that a type as mapped contains no variations in the characters used in differentiating types. In addition to these known variations which exist in types, there are no doubt other variations whose existence is not suspected and which affect the immediate or even potential crop-producing power of the land. Our estimation, then, of the agricultural value of a piece of land is a more or less close approximation, and cannot be considered to be an exact statement.

When we come to the matter of the fertilizer requirements of the various types, I fear that we have less reason to congratulate ourselves on our success in securing this important information. In Illinois we have little information regarding this matter. In looking through the Illinois Soil Reports, one cannot help but be impressed by the remarkable uniformity in the recommendations made for the treatment of the various types. It is quite possible that there are many types which have identical treatment requirements, in fact, it seems reasonable to assume that such is the case. However, assumptions, when dealing with soil problems, are extremely dangerous, and it is the function of the soil survey and its allied activities to determine in as scientific a manner as possible the treatment requirement of each type recognized. If uniformity in requirement is found to exist, well and good, and if it does not exist, a knowledge of the differences is essential.

There are perhaps four major reasons why this information is far from complete at the present time. First, the soil survey is comparatively young and considerable time must elapse before information of this kind can be secured. Second, much, or perhaps most, of the experiment field data available is of very questionable value because lack of replication makes it impossible to determine the reliability of the results. Third, in many field experiments no attempt has apparently been made to determine type treatment requirements. Fourth, many of our fields have been established without giving proper consideration to uniformity of soil with the result that two or more types of soil are frequently found on the same field. The almost universal recognition of the shortcomings of our experimental field work and the steps being taken by a number of our Experiment Stations to correct the deficiencies is the surest proof that before many years we will be well on the way to securing authentic information regarding type treatment requirements.

Two methods of experimental study are available in attempting to predict whether soil types as mapped will have peculiar fertilizer treatment requirements. One is to make a study of the chemical composition of the various types when a sufficient number of analyses are available for such a study, and the other is to make a study of the results of field experiments.

We are all aware that there is a difference of opinion regarding the value of chemical analysis in indicating fertilizer requirements, but probably all will agree that a comparative study of the plant nutrient content of soils will give some idea of their variability as regards both their immediate and potential crop producing power, and hence their response to various fertilizer treatments.

Such a study of the predominant upland prairie type of six adjacent counties in central Illinois, all occurring in the Early Wisconsin Glaciation, reveals that there is considerable variation. Ninety-four samples of supposedly typical areas of Brown silt loam well distributed over the six counties were collected and subjected to total analysis for nitrogen, phosphorus, potassium, calcium, magnesium, organic and inorganic carbon, and lime requirement. The following table shows the variation found in the nitrogen, phosphorus, potassium, and organic carbon content of the surface soil.

	Lowest	Highest
Nitrogen	.167% 3,340 pounds in 2,000,000	.438% 8,760 pounds in 2,000,000
Phosphorus	.044% 880 pounds	.105% 2,100 pounds
Potassium	1.498% 29,960 pounds	2.147% 42,940 pounds
Organic carbon	2.073% 41,460 pounds	5.063% 101,260 pounds

These highest and lowest figures do not represent a few isolated extremes, but similar high and low results are found occurring frequently. This is the more surprising because the samples for analysis are carefully collected from areas thought to be typical of the type. It may very well be questioned whether a type which shows such a wide variation in chemical composition will not also show differences in response to fertilizer treatment.

The second method of study presents difficulties because many of our experiment fields in Illinois as well as elsewhere were located without proper reference to soil type. Also, in Illinois, in most cases the fertilizer treatment is what is known as standard and gives but limited opportunity to make the desired comparisons. A very complete and comprehensive study of the problems presented by these conditions is now well under way, but until it is completed, no statement can safely be made from the Illinois work regarding the correlation between soil type and fertilizer requirement.

The missing reference "Soil classification" by C. F. Marbut can be found on pages 85-94 of "The Life and work of C. F. Marbut"
see 631.4
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Appears to be an error in paging; vol. 2 lacked the same pages when it was bd.

FURTHER IMPROVEMENTS IN THE WORK OF THE SOIL SURVEY

By

A. R. Whitson, Chairman Department of Soils and In
Charge Wisconsin Soil Survey, University of Wisconsin.

It should be recognized distinctly by those interested in or directing the work of the soil surveys that there are several purposes for which such surveys may be made. Moreover people using such surveys are apt to overlook this fact and to judge the survey entirely by the degree to which it meets their individual needs.

The purpose of soil surveys may be classified as follows:

(a) For the direct help it permits experiment stations and extension workers to give the farmer.

(b) For the use of loaning institutions and tax assessors.

(c) For the direction of further research, both along soil lines and other lines based on soil.

(d) For general purposes including (1) encouragement of settlement, (2) educational work, and (3) by implement manufacturers, etc.

The relative importance attached to these different purposes by those in charge of the survey of any state or section will determine to a considerable extent the character of the work done. It is difficult and perhaps impossible to satisfactorily meet all purposes of the soil survey in one general plan. The basis of classification and the relative importance attached to different characteristics vary considerably with the purpose for which surveys are made. In the classification and system of mapping which have been evolved by the Bureau of Soils during the past twenty years, there are two fundamental bases of classification: first, that of texture; and second, that of geological origin leading to the establishment of Series. The first basis, that of texture, is necessarily fundamental in all soil classification. The second, that of geological origin, is helpful for increasing our knowledge of the relation of soils and crops and of various phases of soil fertility, but its importance may be overestimated as a basis of classification for the expression of our present knowledge of soil management. During late years it has lead to a very considerable multiplication of types frequently differing little in agricultural value from those already established.

In the judgment of the writer, the most important object or purpose in the detailed mapping of soils is that of classifying them on such a basis that the farmer may be given the largest possible assistance in further improving of management and adapting his crop system to his soils. Keeping this purpose distinctly in mind will make it possible to very materially increase the efficiency of the soil survey. Among the factors to which further attention could profitably be given, the following may be mentioned.

First, topography. Everyone who has had practical experience in agriculture or in valuing land for agricultural purposes recognizes the very controlling influence which topography exerts. It has a profound influence on the mechanical operations of the farm, such as laying out the fields, the labor of tillage and hauling, as well as on such factors as erosion and drainage. A topography classification should be worked out and used systematically in the work of all soil surveys. The differentation of series takes care of this only to a very slight extent and in an unsatisfactory way. In some cases the use of phases has been made to further express important topographical data, but a more direct and detailed method is desirable. In Wisconsin during the past season we have classified soils in four groups on the basis of topography: first, level or gently undulating and applying for the most part to soils of alluvial origin; second, land undulating to gently rolling, which while having fair to good surface drainage would have little difficulty with erosion and could be readily worked with all farm tools; third, land rolling to hilly and on which erosion is liable to be serious so that its control becomes one of the chief problems in its management, and the land is difficult to lay out in fields and till satisfactorily, so that its value is considerably reduced, although its texture and fertility may be excellent; and fourth, land so steep or stony and broken as to be unfit for cultivated crops. The slope on the first class varies from nothing to 4 per cent, on the second from 5 to 14 per cent, on the third from 15 to 20 per cent, and on the fourth above 20 per cent.

These classes on the basis of topography will, of course, cross classes on the basis of texture or origin; in other words, they will be subdivisions of types as now mapped and must probably be expressed as phases, but the importance of such subdivision is unquestionable from the standpoint of giving practical assistance to farmers or of expressing land value.

Another and somewhat similar practical basis of classification is that of drainage. While it is possible that a consideration of texture together with slope would be sufficient to indicate drainage conditions, it is important that those mapping soils have distinctly in mind the drainage, especially underdrainage, and while it may not be possible to show on the principal soil map the areas needing drainage, secondary maps could readily be constructed at the time the work is in progress which would show the areas needing subsurface drainage or tiling.

Another important practical matter to which relatively little attention has so far been given is the relative state of fertility of the soil of various farms and fields in comparison with the standard or possible fertility of the type or types on which they occur. All persons who have had practical experience in farming realize that the management given to any type of soil has a very great influence on its fertility; so that of two farms occurring on the same type, one may have a very much higher state of fertility than the other. While this state of fertility is somewhat transient and can be modified in the course of a few

years, it nevertheless indicates very definitely where special needs for improvement in practice exist, and the collection in detail of records regarding these conditions would be of the very greatest assistance in extension work along soil and crop lines. On this matter we have in Wisconsin undertaken to indicate by a symbol on our field map a classification into three groups of farms: first, those in a relatively poor state considering the type or types; second, those in average or moderate condition; and third, those in most highly develcped state of fertility. Such information can be gathered with very little additional time and will be of very great benefit.

There are undoubtedly other matters which could be studied and expressed in the work of the soil survey and which would further increase the value of this work. The criticisms which have been made very generally on the soil maps as being made by the various states and the federal bureau that they do not express the relative value of soils accurately, and do not furnish the information which people looking toward the development of special industries need, are undoubtedly more or less well deserved, and in my judgment one of the most important things the institutions having to do with soil surveys can do is to make it a definite object to include these practical matters. I believe it will be possible to retain all the value soil surveys already have from the standpoint of collecting information which may be of further use in the study of soil fertility, and yet greatly increase their practical and immediate value along the lines above suggested and other similar lines.

DUTIES OF THE SOIL SURVEY INSPECTORS

By W.E.Hearn, Inspector, Southern Division, U.S Bureau of Soils.

For the information of those who are not familiar with our organization I will state briefly of what the Bureau of Soils, U. S. Department of Agriculture consists: It has a Chief, Dr. Milton Whitney, and the work is divided into the Divisionof Soil Chemistry, the Division of Soil Physics, the Division of Fertilizers, and the Division of the Soil Survey. Dr. Marbut as you know is the head of the soil survey work.

The United States is divided into five districts each having an inspector--four of these in the east, and one in the far west. Mr. W. E. McLendon has the northeastern part, Mr. T. D. Rice, the northwestern, Mr. Macy H. Lapham, the western, and Mr. H. H. Bennett and I have the southern part. My territory comprises the states of Maryland, Virginia, North Carolina, South Carolina, Georgia Alabama and Florida. Mr. Bennett covers the remainder of the south.

In the inspection work usually two or more visits are made to an area or county. The first trip is made at the time, or soon after the field man begins the work. On this trip we go over all parts of the area with the field man endeavoring to obtain a general idea of the soils, that is, to classify soils into series, and so far as possible identify the types, and to see their relation to the established series. In many counties the soils will naturally fall into old well recognized series, while on the other hand, it may happen that one or more new ones may be developed. In many cases the field man has serious problems, particularly, if he has not had experience in an area of similar soils. It is the work of the inspector to correlate the soils, decide upon the series, and to keep down series unless the material possesses characteristics sufficiently definite to warrant the establishing of a new series. All of you are more or less familiar with the factors to be considered in establishing a soil series. These are color, texture, structure, origin, topography, drainage, and the presence of carbonates. A series has different characteristics just as certain characteristics are developed in a Holstein cow, or a Poland China hog. Of course, soils naturally grade into each other, and in many cases there appears to be a close similarity between some of the series perhaps in one locality, but a greater difference may exist between these soils in some other region. In moving the men from one section of the country to another it frequently happens that an inspector is needed in two or even several places at about the same time. To be at all of them at the same time is a physical impossibility, but we try to reach the area as soon as convenient.

Our second trip is made about the time, or a few days prior to the completion of the field work. Again we go over the county, see and study every series and if possible, every type for the purpose of final correlation. Generally about 95 to 99 per cent of the soils run uniform to some established series or a new series can be made, but there are always a few small areas of soil which give trouble. These are not distinct in themselves, that is, they do not fit into any series, and yet they are not sufficiently different and of enough importance to make a new series. Such soils may be shown as phases of types. It frequently requires considerable judgment on the part of the inspector and soil man to dispose of these so-called odds and ends and to decide upon the exact types which shall stand and be written up in the report. It saves the field man

a great deal of worry and most cases considerable time to have these questions decided for him in order that he may know what types he has to write up in the report and what samples are necessary to take. It is the duty of the inspector to see that the soils are not only properly classed, but accurately outlined on the map, to suggest certain revision in case it is necessary, and assist the new men with their report writing.

After the field work is completed and the maps and reports are turned into the office, there is a great deal of work for the inspector yet to do. He has to write up the final correlation memorandum for Dr. Marbut, in many cases make changes in the report, or combine soil types, rearrange material and check up statements so that the report may be clear before it is turned over to the editor. It is also necessary to spend, in some cases, much time in assisting the draftsman in the office whenever the soils or other things on the field sheets are not clear. To sum it up the inspection work begins with the survey and does not end until the maps and reports are turned over to the engraver and printer.

The imperative need for inspection work, or it would be better to say correlation, is that the field man does not have an opportunity to see the soils in all parts of any given territory, or to obtain the broad relationship existing between them. As an example, a man working in a Piedmont county of North Carolina, or Viginia, and another man working in a Piedmont county of Georgia may have similar soils, yet each might think the soils different from those mapped by the other man, and so this would apply to the whole country. Thus the inspection and correlation work is essential for the purpose of taking care of all of these problems and carrying the information to the field men in order to keep down the number of unnecessary series.

DUTIES OF INSPECTORS

Discussion by T. D. Rice, Inspector, Northern Division, Bureau of Soils, U. S. Department of Agriculture.

Besides the inspection of the field work and the correlation of the soils, there are other duties of equal importance connected with the field work of the inspector which I will briefly mention.

It is the duty of the inspector to visit the college, experiment station, or other agency with which the Bureau of Soils is cooperating. Usually the state cooperator wishes to visit the areas with the inspector. In cases where this is not possible, it is the duty of the inspector to report to the representative of the state the general progress of the work, and discuss any problems that arise in the course of the soil survey.

The inspector should be a carrier of information. Nearly all of our soil surveyors are in the field the entire year. They get out of touch, or feel that they are out of touch with what other field men are doing, with what the laboratory men are doing, and with what is being written on soils and related subjects. It should be the duty of the inspector to carry to the field men the results of research in every branch of soil science. The soil survey is itself a branch of true scientific research, and is in a way a graduate school, the members of which should be advancing in knowledge. The inspector should therefore bring new facts to the attention of the field men, and should show them the application of new ideas to their own problems wherever such application can be made. Every field man with such information will feel that he is more in touch with the great body of soil scientists and will be encouraged to observe soils more closely, and to study more carefully the problems with which he is confronted.

An important duty of the inspector is to keep up esprit de corps of the field force. The field man no matter how cheerful, or how willing he may be, who does hard physical labor day after day, and month after month, often alone, is liable to develop a feeling of discontent. From my own experience I know that this feeling is greatly intensified if no one visits him from the office, and no one seems to pay any particular attention to the work. He naturally feels that he is neglected and that it is a matter of indifference whether he does good work or not. This feeling of loneliness and discouragement may seem foolish and temperamental to one who has never done lonely, monotonous field work, but it is quite natural and has a marked affect in many cases upon the progress of the work.

More serious and disagreeable however, are other troubles with which the inspector has to deal; the differences that arise between the field man and the office, and the enmities that arise among the members of a party. Now the inspector can ignore these troubles--often it is a part of wisdom to do so--but if it is in his power to harmonize differences and decrease friction, the inspector is not doing his duty, and is not loyal to his position if he does not attempt to do this.

Photographs by U.S. [illegible], Bureau of Soils,
U.S. Department of Agriculture.

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THE CORRELATION OF WEATHERED TRANSPORTED SOILS

Chas. F. Shaw
Professor of Soil Technology
University of California.

At the meeting of this Association a year ago, a question was asked regarding the correlation of bottom land soils which had been reclaimed and protected from overflow by the construction of levees; the question indicating the possible feeling that such soils being no longer subject to periodic inundation, should conceivably be classed in a different soil province as "terrace" soils. In our western surveys we have to do a great deal of work on transported soils. In fact by far the major part of the soils possible of agricultural development lying west of the Great Plains are made up of soils that have been transported by wind or water. In California over 75 per cent of the arable land of the state has been covered by detailed or reconnoissance surveys. Of the 25,700,000 acres on which the measurements of the soil areas have been completed and tabulated, we find that about 5 million acres are classed as non-agricultural (rough mountainous land, riverwash, etc.), about 4 million acres are residual soils, over 300,000 acres are peat and muck, and over 15 million acres are transported soils. Of the latter, about 6,600,000 acres are "Recent Alluvial", over 500,000 acres are "Aeolian" or wind-transported soils, about 800,000 acres are "Lacustrine" or lake-laid soils and over 7 million acres are "Old Transported" or "Old Valley-filling" soils, these latter being comparable to the "Terrace" soils of the east. In other western states the relative importance of the transported soils would be about the same as in California.

In the strictly arid portions of the country much of the transported soils consist of alluvial fan deposits. The alluvial fans are great aerial deltas built by streams having an intermittent or greatly fluctuating annual flow. They consist of a mass of water-borne materials of a typical fan or cone shape with the apex at the mouth of the canyon through which the stream emerges from the mountains, spreading out from this point with a decreasing gradient out towards the center of the valley. The individual alluvial fans built out from the many canyons, coalesce to form great slopes of deep alluvial material. Each year the streams that form these fans overflow their channels and carry out their annual load of sediment which is spread over the fan through the many distributaries and added to the increment of the previous years. On the upper parts of the fan, the soils are coarse and stony. The intermediate slopes are sandy, while the lower, flatter slopes are heavy in texture. Usually the fans from the different sides of the valley lead out to a central basin where the heaviest clays are deposited under semi-lacustrine conditions.

When for any reason there is a change in the regional drainage systems brought about usually by changes in the elevation which would increase the gradient of the land, the streams that have previously built up the alluvial fans begin to cut through these deposits eroding them and carrying the new load of material out to be spread on a new lower fan farther out towards the center of the valley. In some cases we can find two or more generations of alluvial fans showing the occurrence of successive uplifts or tilting of the mountain blocks that border the valleys. This change in drainage conditions is responsible for certain marked changes in the character of the soil. The alluvial material that previously had been under a condition comparable to that of an

eastern river bottom with periodic overflow and addition of sediment now becomes a region subject to erosion and to the attacks of the weathering agents. In my discussion of the changes in the soil section brought about by these agencies, I will ignore for the present the modifications brought about by erosion and will consider only the changes that occur in the soil which remains in place.

Under conditions of heavy rainfall or under normal humid conditions, these soils would go through a continuous process of leaching with the result that the readily soluble bases, particularly lime, would soon be removed from the surface soil and carried deep down into the soil mass or possibly through to the ground water and out through the underground drainage systems. Under conditions of lower rainfall, the lime would be carried from the surface soil down to the subsoil or substratum where it would be more or less concentrated as a lime bearing or calcareous layer. The lime might accumulate as nodules or small concretions, or as seams, lenses, plates or layers of calcareous material. At the same time that the lime and other soluble materials was being removed from the soil by leaching, there would be a progressive development of clay particles due to the weathering of feldspars and other hydrous aluminum silicates with a migration of this clay into the subsoil. This clay migration is quite evident in any of the older soils, either transported or residual. The heavy subsoils that are characteristic of nearly all of our residual soil series are due to a considerable extent to migration of the clay. The heavy and sometimes nearly impervious subsoils of the soil series derived from glacial till are due in a very large measure to the downward movement of the fine clay particles and their accumulation in the subsoil. The same thing is true of soils that were originally transported and deposited by water or by wind. The heavy subsoils that are characteristic of most of the series in the Atlantic and Gulf Coastal Plains are due in a large measure to the downward migration of the clay resulting from the weathering and leaching of these water deposited materials.

It is easy to recognize these evidences of progressive weathering when the changes that have taken place are so striking and so complete. In our western work we frequently encounter soils which have been weathered for a relatively short time or which have been weathered under conditions of such restricted rainfall that the result is not at allpronounced and the age, as evidenced by degree of weathering, can only be determined by careful study. Under strictly desert conditions where the occasional rainfall is usually accompanied by deposition due to the flow of water over the alluvial fan, there is little or no leaching taking place and the Recent soils contain lime in the surface layers. If, however, the rainfall is somewhat higher or the volume of water spread over the fan appreciably great, the lime is leached from the surface soil and hence the presence or absence of lime in the surface is not a safe indicator of the relative age of the soil. The presence of lime in the subsoils or at any zone or horizon a short distance below the surface, is an indication of at least the beginning of soil weathering, the beginning of early maturity of the soil mass.

The migration of the clay begins very early in the weathering of the soil mass. The colloids that are formed during the times when the soil is wet, are carried down through the interstices of the soil, and accumulate in a definite subsoil zone. This accumulation is evidenced first by a slight compacting of the subsoil layer which when dry may become hard and difficult to cut with the auger, but which will soften up and be readily penetrated when wet. The soils also show a tendency toward stickiness, and usually there is a sufficient accumu-

lation of lime to give a slight effervescence when tested with weak hydrochloric acid.

As the accumulation in the subsoil continues there is developed a rather characteristic jointed structure, with cracks and lines of weakness quite similar to the columnar structure developed in basaltic rocks. This structure may exist at any degree of intensity from that of a very slight development with some indications of parallel cracking to cases where the subsoil is decidedly dense, cracked into more or less regular columns and jointed in a very regular manner. The zone of jointing is usually quite distinct from the soil above and from the deeper subsoils below. This is due to its progressive development, for as the downward migrating clay accumulates in the pores in the subsoil zone, it decreases the possibility of colloids passing through and consequently tends to concentrate the deposition in the upper parts of the zone, making it markedly heavier and more compact.

In those soils which contain considerable quantities of readily soluble silica and iron, the progressive weathering which accompanies the formation and migration of the clay, will also develop considerable quantities of iron and silica compounds which may be either in a completely dissolved condition or may exist as colloids. These materials will be carried into the subsoil zone and there precipitated, making the subsoils more and more compact and impervious until in time they become so thoroughly cemented that water or roots can no longer penetrate them. This accumulation of iron and silica cementing materials in a subsoil zone gives us our "red iron-hardpans" that are characteristic of a considerable area of the soils of the state, over two million acres having already been mapped. The hardpans vary in depth below the surface, this apparently being determined by the depth of penetration of water during formation and by the amount of subsequent erosion. They also vary in thickness and in hardness, these features being apparently related to the relative age of the soil mass. The hardpan layers are hardest on the upper or top portions, and the iron and silica may continue to accumulate on the top of the cemented zone to the extent of forming a thin, very hard layer of hardpan closely resembling an iron bearing sandstone rock or even as thin plates of impure hematite.

In our work in California we have encountered soils in all these stages of weathering. For instance, our recent alluvial soils from granitic rocks may fall into the following general succession of series. The newest and rawest washes where the soil has had little opportunity of weathering generally have a light gray color and have been classified as the Tujunga Series. Where this material is spread over a broad fan on which vegetation grows each year, and some alteration of the soil grains may take place, but where there is no evidence of any changes in the subsoils or any real evidence of weathering, it develops a brown color and other changes in character and is classed as the Hanford Series. There are other series in this succession, the Foster and Chino, whose differences, being due to differences in drainage conditions, I will not discuss.

On the valley margins above the present fans of Tujunga and Hanford soils, we find the terraces and benches that have been formed of the same kind of granitic material, and with definite evidence that it was laid down in the same manner as the lower and younger fans. An elevation or tilting of the mountain block or the over-building of the fan with subsequent off-slipping of the water courses, caused the parent stream to abandon the deposit it was building up, and to start active erosion and destruction of these fans. The benches and terraces are the small remnants of the former extensive alluvial slope.

Where material, that was originally comparable in every way to that which forms the Hanford Series is weathered for a period certain changes in character and structure occur. The soils develop a richer brown color, often with a slightly reddish tint when wet. The subsoils become more compact, develop a heavier texture, a somewhat jointed structure and show a tendency to become sticky when wet. These changes are sufficient to materially affect the water-relations of the soil, and to modify crop adaptations, and irrigation and tillage practices. We recognize these changes as sufficient to warrant a series distinction, and have recognized these slightly weathered soils as the Ramona Series.

Where a longer period of weathering, or a greater intensity of weathering activity has taken place, we find that the soil has suffered further changes in character. The color becomes reddish brown with a marked redness when wet, and a tendency to bake together in harder lumps when dry. The subsoil becomes much heavier and shows a definite jointed and columnar structure. When dry it is very compact and hard, while when wet it is quite sticky, becomes softer and can be readily penetrated with the soil auger. This condition we have recognized as the Placentia Series.

When weathering of the same class of material has progressed to the stage of cementation instead of compaction of the subsoil, a real hardpan is present. This hardpan is practically impenetrable to the auger or to water or roots, and these hardpan soils are recognized as San Joaquin, Madera, Redding or Alamo Series, depending on color, character of substratum and other related features.

Where the weathering has progressed to a considerable extent, it is not difficult to distinguish these different soil series. Where erosion has been active since the parent stream abandoned the deposit, it is not at all difficult to recognize the older soils, their age being readily evidenced by the irregular rolling, hummocky or terrace-like topography. Our great difficulty occurs when we find a region in which erosion has not been active, a region which has a topography indicative of youth with smooth, regular slopes, uniform in surface configuration. In such places we must depend for our evidence entirely on the soil section, and must, through many borings and careful examination of the subsoil, determine whether or not there has been an appreciable migration downward of clay with or without a concentration of lime and the compacting and possible cementing that accompanies continued weathering.

In answering the question which was raised a year ago, I would then say that leveeing a river bottom would not immediately change or alter the soil and consequently would not warrant its being put into a new group, as, for instance, moving it from the bottom lands to the terrace group. The action of the weathering agents is very slow and it is hardly possible that material changes could be produced during a normal lifetime. Undoubtedly, such protection from overflow will ultimately induce changes in the soil character that would warrant a future change in correlation. Such changes should be made only when the character of the soil section and particularly the subsoil is such as to definitely indicate a change in the soil condition and the separation should be based not on the purely artificial and accidental point of protection from overflow by human interference, but on a progressive development of new conditions within the mass of the soil itself.

SUGGESTED IMPROVEMENTS IN SOIL MAPS.

By W.J.Geib, Wisconsin Cooperative Soil Survey.

After over 20 years of constant effort on the part of a comparatively small group of soil workers, the making of soil maps has reached a high degree of accuracy. Soil surveys were started in the United States by Prof. Milton Whitney and the Bureau of Soils stands today as evidence of a constructive idea put into practical application. The soil survey may be considered one of the most essential and basic factors in the higher development of a permanent agriculture. Soil surveying, however, may still be considered a new science and in its short period of development many difficulties have been met with and overcome.

The many and varied uses which are being made of soil maps suggests that this line of work has still greater possibilities. Aside from the uses for which the maps were originally designed there are coming to be many other fields into which these maps are being introduced. Some of these were doubtless anticipated by the early soil workers, but many of them were not.

The chief use of soil surveys at present is by the Agricultural Colleges and Experiment Stations who are guided by these maps in advising farmers as to the needs of the soil in particular localities, and how these soils should be treated. Without soil maps a soil advisory service would be of very inferior value. Other users are County Agents, teachers of agriculture, extension workers, land commissioners, immigration agents, colonization companies, land buyers, road and drainage engineers, tax commissioners, and bankers. Many industrial concerns also find uses for the maps. Many other uses could be enumerated. Is it true, however, that in none of these special fields, nor in the field for which soil maps were designed is their use as common as we could wish, nor as extensive as their accuracy would warrant. The fact that soil maps are used in so many widely different activities, even in a limited way, indicates that there are very great possibilities for the more extensive use of our product. We believe that one reason why there is not a more extensive use made of our maps in these many fields is that the maps, in their present form, are not well suited to such varied uses.

If we will go back for an instant to the first soil maps which were made and examine into the field methods used we will find that they differ very widely from the methods now in use, and especially in regard to the accuracy of the maps made. Many of the early surveys were made simply by traversing the roads and examining the soil adjacent to the highways. Whereas at the present time the land is often traversed at intervals of one-fourth mile and sometimes even closer and all variations of from 5 to 10 acres are shown, whether these variations are along the road or in the center of tracts some distance from roads. This closeness of traverse insures accuracy of detail in mapping.

In the matter of classification much progress has also been made. In the early mapping, for example, the Miami series included practically all material in the Glacial and Loessial Province which was upland and light colored. At present there are at least eight series where previously only one was recognized. This recognition of a great variety of differences in what was previously mapped

as one series means that at present we are able to distinguish minute differences in texture, color, structure, topography, chemical composition, and that we can interpret these to a large degree in terms of agricultural value. It is very evident from the above that in the field work and also in the classification very marked progress has been made, and the maps are now scientifically correct, and herein lies the tragedy--if such it may be called--we are making a highly scientific product which is being used by people, many of whom have had but little scientific training, and especially soil training. This means that most people have some difficulty in reading our maps. It is doubtless true also that many people who have had scientific training but along other lines find it difficult to interpret soil maps. This is a condition which no live business organization would tolerate--in fact to follow such a policy would be suicidal. The manufacturer of any product must study the conditions under which his product is to be used and by whom it is to be used, and just so far as possible adapt it to such uses and to the needs of the people whom he supplies. The manufacturer must know how and for what his product is to be used before he makes it. He may often be able to extend the uses into new fields by making slight modifications in the product which will in no way interfere with the use for which the product was originally designed. So it is with soil maps, and what we have to suggest is simply applying every day business principles to the work which we have in hand. No matter how we figure it out I believe we must come to the conclusion that the ultimate consumer of our product is the farmer himself, and unless we make a product which can be readily used by him we will fall far short of reaching the greatest possible success. Some may say it is possible for other agencies to interpret maps for the farmer, but if this is done he will not be favorably impressed with the maps from a practical standpoint, and will not support a program for their more extensive development.

I would like to depart just an instant to say that I do not believe it is enough for us to make soil maps and make them perfectly, although this in itself is a good man sized job. I believe it is for us to find as many uses as possible for our maps and to give instruction in the uses of the maps in new as well as old fields. If we do not advertise our product it is quite likely that other people will not do it for us. This question could be greatly enlarged upon, but it is beside the question under discussion.

As indicated before, great progress has been made in the field work of the soil survey and also in perfecting the classification, and much credit is justly due those who have had this work in charge, but if we will examine one of the early maps we will find that in all essential features it is identical with the soil maps which are being made today. That is the soils are shown by colors, the naming of the types is the same and the legend is the same. In other words, we have made wonderful progress in part of our work, while in another, and very important part we have practically stood still for 20 years. Had the first soil maps been as nearly perfect as the early Ford engines then marked modifications would not be necessary. Ford cars have come into almost universal use in 10 years, but soil maps after nearly 20 years are still but little used by the vast army of people to whom they could be made of value.

We have no suggestions at this time as to the methods employed in showing soil variations on the map, for we believe the use of distinct colors cannot be improved upon. Some means of showing topographic differences could be employed which would be an improvement over 20 foot contour lines, but that

also is another story. The point at which we wish to attack the soil map is through the legend, and the present difficulty in reading and interpreting the soil maps.

The name Miami silt loam means but little to the man who has not made pretty careful study of the Bureau soil reports. To find out what this term means it is necessary to read a soil type description in the report. If there are several soils to be looked up it takes some time and often inconvenience to get the desired information. The man who really needs it will probably be able to get it, but the man we want to help most will probably become discouraged before his interest is very great, or before he finds what he should know. Maps of the size of ours can best be used as wall maps, yet in their present form our maps are poorly suited to such use. Where there is frequent use for the map as in a bank or school or office, it is soon torn by frequent unfolding and folding.

Briefly stated and to get at the meat of the whole matter it is suggested that the legend be revised so that the map in itself will tell a more nearly complete story. That is from the examination of the map itself a man would be able to gain a fair idea of each soil type shown. In addition to the usual scientific name of the soil there should be a brief description of the soil, subsoil, topography, drainage present uses and needs of the soil. This material could be arranged in tabular form and would take up comparatively little space, yet it would add very materially to the value of the map, by making the interpretation of the map much easier. The various soils could be grouped according to texture. so that some parts of the description would not need to be repeated. In addition to the change in the legend there should be a large caption at the top of the map, giving the name of the county so that when used as a wall map it could be read at some distance. The accompanying illustration shows how this legend and caption could be arranged. On different maps the arrangement could be different depending upon the shape of the area, and the available blank space.

These maps could be published on the same kind of paper as now used and could be folded in the back of the report as at present. Those who received them could use them as wall maps should they so desire simply by putting a stick at top and bottom. They could be mounted also but this would not be necessary. States having special editions run off could have some of these put on special map paper or cloth suitable for use in schools, banks, etc. and these could be sold at cost. The cost for making these additions to the original map would be very small, but to have the extra editions made after this fashion after the Bureau had first used the other form would be very expensive.

If we wish to gain greater support for the soil survey work I believe we must make our work just as popular as possible and this can be done with out detracting from its scientific value. People must know our work, and feel that they can use it before they are going to demand or want more of it. And until people actually want our maps, we are going to have a very hard time trying to get increased appropriations. If we can show every school, bank, and farmer, in the area surveyed that the soil map will be of some value, then we will not need to worry about legislative support. If we are prepared to adopt business principles in the manufacture and sale of our product the demand for it can be materially increased. With this increased demand there will shortly come the means for increasing the output of our product.

In case this, or some other, plan for the improvements of soil maps meets with the approval of the Association, it is suggested that a committee be appointed to make a more thorough study of the possibilities along this line, and to determine the probable cost involved in changing from the present system of map publication to one including the changes herein outlined.

DISCUSSION ON HOW TO IMPROVE SOIL MAPS.

By W.H.Pierre, Of South Dakota Soil Survey.

The improvement of the legend as suggested is, I believe, the greatest improvement that can be made in the soil maps at the present time. The legend is the key to the map and as such should be made as simple and yet as comprehensive as possible.

The explanatory legend in tabular form accomplishes this. True it might be said that a person desirous of knowing more about the soils found on the legend at the present time need only refer to the report. But, just as the introduction to a good speech or magazine article is made as interesting as possible to interest thelistener or reader in what follows, so soil maps that are made interesting and comprehensive in themselves are more likely to get a "half interested" person to read the report than one which cannot be interpreted as readily. Moreover, soil maps will become of greater value. Their use will become much more general, for then it will be possible to mount them and use them as wall maps in schools, banks, post offices, and even hotels. And, as a result of this, greater publicity will be given the work and greater support and cooperation secured.

A small improvement could also be made in the culture legend. The enclosing of three or four conventional signs in one rectangle as is now used makes the legend somewhat misleading and difficult of understanding, especially by persons not used to reading maps. For example, it is difficult to tell what all the signs in the first large rectangle stand for, or to distinguish the signs for trail and secondary road, mine and mine dump, or swamp and salt marsh.

The using of a different sign for a church and a school house, although probably of minor importance, should also be recognized. It would very likely mean very little additional expense, but would mean much to the farmer trying to locate his farm with reference to a certain church or school. Moreover, I believe that any signs not used on the map should not be included in the legend. No doubt, there are good reasons for having a standard legend, but the more simple a legend can be made the more easily it will be understood.

With reference to the colors used on the maps at the present time, the general policy has been, I believe, to use strong contrasting colors between adjoining soils. This color scheme is effective, but I believe it could be made more effective if the contrast between soil types in a certain physiographic province could be made subordinate to the color contrast between different physiographic provinces. To explain,--if in a certain county part of the soils are of glacial, part of loessial, and part of alluvial origin, the color contrast between these different provinces should stand out on the map distinctly or above the color contrast of the soils within any one of the given provinces. True, it is always possible to trace the line between upland and bottomland, but if the color scheme can be such that at first sight this line of demarcation stands out, the map will be greatly benefited, and farmers (especially) will get the idea of soil differences, shown on the map, more readily.

Certain difficulties in engraving might probably be encountered at times by using this scheme, but I believe that whenever possible the color contrast between soil types should be subordinate to the color contrast between soil provinces.

LABORATORY METHODS OF VALUE TO SOIL SURVEY.

By M.M.McCool, Prof. of Soils, Michigan Agricultural College.

Any laboratory method that may be utilized to provide us with information relative to the fundamental properties of soils should be of value to the soil surveyor. We are forced to admit that many phases of our knowledge of soil science are in reality very meager, thus there is much to be accomplished.

The physico-chemical studies may afford us much information that would be of really great value to the soil surveyor. The water relationship, for example, is probably one of the most fundamental and far reaching that could be studied because of the tremendous importance of water in so many different ways. By means of the water relations of soils we may study such problems as the weathering of soils, the structural relationships and also the size of particles. I am referring here to the investigation of different forms of water; and in addition the heat of wetting of soils may be used to great advantage in connection with the soil survey. The determination of the hygroscopic coefficient and moisture equivalent of soils has in the past revealed valuable information and probably is yet to be used to advantage yet it seems that they are not sufficient.

We need to know more about the weathering of soils, that is the formation of various horizons, their composition relative to the different elements that go to make them up. Then, too, there is the question of soil coloration. There are several phases of this to be settled. Have we gone too far with it in our investigations of soils or have we considered it sufficiently? Again, we need to know more about the constitution of the soil, not merely the per cent of the nitrogen, phosphorus, potassium and others but the combinations in which they go into solution, reactions that take place when various substances are added to them and others. The degree of acidity and basicity are important in the classification of soils.

In some of the northern states where the acreage of organic soils is high we are forced to make advancements in our present methods of classification and not merely to show on the maps whether such deposits are deep or shallow. Such questions as the nature of the materials that go to make up the surface and subsoil and also the total mineral, lime content, moisture relationship, the adsorptive properties and others are important. Such is not only desirable from the agricultural viewpoint but also from the industrial standpoint.

Those who have worked in this field probably realize that there is much that can be done from the laboratory standpoint to aid in the classification of these soils.

When we consider these various aspects we are forced to conclude that the soil surveyor should have the view point of the scientist and when he goes into an area to classify the soils therein he is really taking up a piece of research work that is worthy of his most serious consideration and study. He has much more to do than merely to locate the boundaries between different types of soil and report to the inspector. He has opportunities almost daily to make note of conditions that are of fundamental value to the soil survey as a whole. Many of these conditions he should not only make note of but also should attempt to account for them. This is true because the inspector usually can not spend

sufficient time in the area and go over it in sufficient detail to note many of these. The point that we wish to make is that the soil surveyor should fully realize and appreciate that he has a great work to perform in each area and that the work is not merely a mechanical proposition but entails keenness of observation, thought and careful attention to details as well as to the broad relationships.

Physico-Chemical Methods.

At our last meeting in Chicago we stated that probably no other relationship tells us as much about the soil as does the moisture. We still believe that this is one of the best means of studying many properties of the soil. It may be utilized to investigate such subjects as weathering, solubility of the soil, structure of the soil, size of particles and others.

The Dilatometer Method. I shall discuss first the dilatometer method which may be utilized to advantage. This hinges on or makes use of the fact that water expands upon freezing. If one knows the coefficient or expansion of water upon freezing and also the total water content of the soil he can calculate the amount of water which freezes and that which does not freeze at a given temperature. I need not discuss the technique at this time inasmuch as it is probably familiar to all of you.

It has been shown that appreciable quantities of water in the soil may fail to freeze. It must be of great significance inasmuch as it is different from that water which readily solidifies. There may be a difference of opinion relative to the causes of this phenomenon and the form in which this water exists in the soil, that is whether it is liquid, solid, water of hydration, capillary adsorbed and etc., but the fact still remains that this is a characteristic of many soils and must be an important property. We believe it may be made use of to decided advantage in connection with the soil survey, pointing out the fundamental relationships so that the surveyor may be on the look out for various properties and characteristics.

Empirical methods are not sufficient. Not only is the fineness of particles important in governing the activities of the soil as measured by the dilatometer method but also the composition or state of the material. We know that crystalline materials may be rather inert and those that are in the amorphous condition much more active. We may pulverize or grind a large number of minerals, as Dr. Bouyoucos has done, that we know go to make up a soil and mix them together and make determinations of their activity relative to this phenomenon and they will be found to be quite inert, yet when they are in the soil they may be exceedingly active. Carbon black is known to be very finely divided material but it is inert. If it is heated to a certain temperature it is known that its properties are markedly altered and it becomes exceedingly active yet the surface exposure or fineness of particles probably has not been altered to any great extent. Clay when ignited largely loses its power to take water from the easily freezable form and place it in a difficultly freezable class. In other words the active material in the clay is destroyed by the treatment. Colloids seem to play a very important role in governing the activity of the soil. Bouyoucos has shown that there is no definite and consistent correlation between the factor of the unfrozen water and the class determined by mechanical analysis. It is undoubtedly true that there is a general tendency for the quantity of unfrozen water to increase from sand to clay and from clay to organic soils but

there may be exceptions. Some sandy loams, for example, may be as active in this respect as clay loams as determined by mechanical analyses.

That the nature of the material is extremely important in governing the activity of the soil may be strikingly shown by our studies on organic soils. The amount of organic matter may not be so important as other things. The following may serve as an illustration. Samples were taken from different deposits, the ash content determined and the amount of water that they cause to go into an unfreezable condition found to be as follows:

Organic matter	Unfree Water
92.6	46.2
90.4	49.2
89.7	41.2
85.8	62.5
84.2	79.0
78.2	70.0
71.8	55.2

If as we believe to be the case the seat of most of the reaction that takes place in the soil is at the surface of the particles, or solid material and if the larger particles are coated with colloidal material in some cases and are not in others there should be differences in the properties of such soils. Such conditions are not revealed by mechanical analyses of soils. It is true that the mechanical analyses have been of a great deal of value to the soil surveyor yet we believe that it is not sufficient in itself.

Soil Structure. This raises the question of soil structure. I suppose all agriculturists agree that the activity of the soil with respect to structure is of tremendous importance. It is our judgment that the future will see a great deal of energy expended on this subject. We are forced to admit that our knowledge of soil structure and what really causes the changes in it is greatly limited. We believe that by means of moisture studies that much information will be derived. This question is under investigation but we are not ready to publish results that have been obtained thus far.

Usually the activities of the soil do not involve the individual particles but very often these function as groups, and if such is the case it would seem that further investigations on this question are indeed necessary and essential. Not only the various activities of the soil in connection with water relationships but others should be governed by the mechanical condition of the soil.

Chemical Studies.

There are possibilities along analytical lines as these have not been exploited to the fullest extent. We are now speaking and writing of profiles or horizons of soils and describing them with respect to color, texture and structure so far as can be done. What differences are there in these layers that are described, that is with regard to the effect that weathering has produced? Analytical work, we take it, should point out the effect of these forces and should not necessarily be done with the point in view of determining the number of pounds per acre of nitrogen, phosphorus, potassium, calcium and others, although this may be desirable in another connection. I am speaking from the

viewpoint of the work that will be of value to the soil surveyor or that which will cause him to pay, if possible, more attention or be on the look out for differences in the surface as well as the subsoil to a greater extent than has been done in the past. The unpublished work of the Bureau of Soils and associates and that of Dr. Alway of Minnesota is especially significant as well as that of others. Wheeting of this department has done considerable work on the weathering of glacial material to produce Miami and other soils.

As Mr. Veatch has brought out, there are certain characteristics of the soil horizons in the northern part of Michigan, especially in the Upper Peninsula. Now what differences are there in these various colored layers? Are they measurable? What causes these? What do they signify? Was the grayish material caused by the leaching of organic compounds from the forest floor and the removal of certain constituents and their deposition lower down and was organic matter transported in the solid state, such as the colloidal form? What effect, if any, has heat had upon this condition? Would the burning of the forest floor and the resulting high temperature of the surface layer of soil bring about sufficient changes relative to the amount and nature of the materials that go into solution and thence into the soil effect it in addition to the ways just mentioned? We are using colorimetric methods in part in the identification of soil types and in other ways. Have we gone far enough or too far in the use of color characteristics in the classification of soil? It is probable that there is considerable to discover in this field.

The work of Bouyoucos is suggestive in this respect. Here we have the mineral orthoclose that was ground sufficiently fine to pass a 200 mesh sieve, treated with different salt solutions and let stand in a moist condition. We find that very striking changes have taken place as measured by colorimetric methods. As you may observe the color changes are striking and variable. The rate of change was observed to vary markedly with the different treatments. Many other minerals and rocks have been powdered and studied in this manner. Although there remains much analytical work to be done here is some food for thought it seems to us in connection with soil coloration and I again raise the question--have we gone too far or not far enough in the use of color characteristics--in soil classification?

Much is to be done on organic soils. In this state we are being called upon to classify organic soils in far greater detail than has been done in the past, and are attempting to do so. We have come to the conclusion that there are about as striking differences in this group as occur in the mineral soils. Those who have made field observations realize that there are vast differences in the rate of drainage of different deposits; in some cases these soils are almost impervious to waterand are wet or boggy at relatively short distances from open ditches, whereas in other cases a ditch takes care of the drainage over a distance of many rods. Some of the highly colloidal ones become extremely intractable upon drying and several properties are greatly altered thereby.

Again the activity, that is the rate of decomposition and solution of the surface and different layers or horizons that occur in these deposits may vary tremendously. Some are practically inert even at room temperature while others are very active. In some instances we have found that the upper layers are more active than those lower down while in others the reverse is true. Some have very high fixing power for phosphorus and potassium when they are added to them in solution, while in case of others it is feeble. The acidity as measured by different methods including the Ph varies widely. Thus we believe that laboratory viewpoint of the work that will be of value to the soil surveyor or that which will cause him to pay, if possible, more attention or be on the look out for differences in the surface as well as the subsoil to a greater extent than has been done in the past. The unpublished work of the Bureau of Soils and associates and that of Dr. Alway of Minnesota is especially significant as well as that of others. Members of this department have done considerable work on the weathering of glacial material to produce black and other soils.

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The work of Gortner is suggestive in this respect. Here we have the mineral orthoclase that was ground sufficiently fine to pass a 100 mesh sieve, treated with different salt solutions and let stand in a moist condition. We find that very striking changes have taken place as measured by colorimetric methods. As you may observe, the color changes are striking and variable. The rate of change was observed to vary markedly with the different treatments. Many other minerals and rocks have been powdered and treated in this manner. Although there remains much analytical work to be done here is some food for thought. It seems to us in connection with soil coloration and I again raise the question--have we gone too far or not far enough in the use of color characteristics--in soil classification?

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Solubility

The solubility of the soil may be studied to advantage. The solubility of minerals does not depend solely on the size of the particles. If minerals are ground very finely so that they will pass a 200 mesh sieve or finer and are brought in contact with water considerable material goes into solution in a relatively short time, the amount varying with the kind of mineral. When these powdered materials are leached or the soluble constituents or the products of the reaction are removed and they are again left in contact with water, the rate at which soluble materials usually form is very slow. If the various components are isolated from soils and studies made on the relative solubility of each, our investigations show, on soils that we have studied, that the finer particles account for much of the activity of the soil in this respect. If the sands or coarser particles are ground so that they will pass through a 200 mesh screen and brought in contact with water their initial solubility is appreciable but if this is removed as in case of minerals or rocks cited above, the formation of the soluble constituents is very slow. Temperature is important.

The investigations of Bouyoucos show that if minerals are brought into contact with water and maintained at high temperatures, they are quite stable. For example, if they are placed in a temperature bath of 53° C they are far more unstable yet their solubility does not increase very much until after they have been under this condition many days. After having been exposed for a considerable length of time they proceed to decompose rapidly and their appearance changes to a very great extent as illustrated by these samples.

Usually soils are strikingly affected by higher temperatures. Thus temperature relationships of soils under field conditions may be of great significance. The rate of formation of soluble constituents and the change in their composition must be increased markedly when the temperature is high. We have determined the rate of formation of soluble constituents on a large number of samples sent to us by Professor Marbut. Several were collected in Africa and a large number in the southern states. Those that are considered to represent the very old soils on the whole were found to be much less active in this respect than others that we have investigated. Such results are suggestive to the soil surveyor in his attempt to account for the variations in the soil. Since the temperature of the soil is controlled largely by its water content those that are poorly drained should weather relatively more slowly than those that are well drained. The parent material should lie somewhat nearer the surface under the former than under the latter conditions.

THE SOIL SURVEY AND ITS RELATION TO CANADIAN AGRICULTURE.

By A.H.Hawkins, of the Canadian Department of the Interior.

That the members of the Association may not consider my presumption in presenting a paper at this meeting too colossal, I should like to make a brief explanation. When invited to contribute a paper to the Annual Meeting of the Association of American Soil Survey Workers, the question that at once arose in my mind was, by what right, or upon what grounds, could I presume to address a body of veterans on the question of soils, and it was decided, that the only position that could be taken would be that of a freshman, and that whatever I might have to say would be merely in the way of an initiation ceremony to a place in the useful and honorable body of Soil Survey workers, and that by due attention to the various numbers on the programme I might be able to gather much information on the all important subject of soils and to use such parts as are particularly applicable to advance our efforts in establishing Soil Surveys in Canada.

We are just beginning the work and are most anxious to gather what information is possible from all sides of the question, so that we may be able to correct, improve, or reject, where the long experience of the members of this Association indicate that changes should be made, and how they should be made.

With this end in view, it is proposed very briefly to tell you something of the events that have been the cause of our starting this work, and to lay before you some of our aims and ambitions that we are hoping will make the Soil Survey and Land Classification a real economic and social factor in Canadian Agricultural development.

I regret that I have to say, that up to the present time, Soil Surveys and Agriculture have had little, if any, relationship to Canada; our policy has been more of the grab-bag variety. If Canadian Agriculture and the Soil Survey had had a much more intimate, intelligent and practical relationship in the past, who can tell what the effect might have been, both economically and socially. Gifted authors write volumes in praise of our fertile and abundant acres; Governments have organized and maintained expensive propogandist missions to induce immigration to make new homes in Canada; Railway companies, Land companies, individuals, all join in the general chorus, telling of our wonderful lands and the bright prospects of those who will come to us; but there, to a large extent, in the past, our efforts have ceased. The settler lands at Montreal, Halifax or New York, and inquires for the promised land. He is told, right before you are 3,000 miles of the finest of the earth. Take your choice--how much wasted money and time, vain effort, disappointment, and sorrow might have been prevented had a reasonable, common sense, humane system of Soil Survey, land classification, and Colonization, been adopted in early days in Canada. Our patchwork settlements would not exist, railways would not pass through miles and miles of fertile but unoccupied lands, which is one of the factors causing the huge deficits that are annually presented to us to make up.

Instead, we could reasonably expect that settlement would be more concentrated, more united, more co-operation would have been carried out, and thousands who selected for their future home, quarter sections, the lands of which were sterile and of such texture and type that no amount of labor could make

them agriculturally productive, would have been saved the bitter sad experience of failure. Not by reason of their own delinquencies but because of lack of information--because Government had failed in a primary duty.

Permit me to lay before you some evidence. As early as 1855 a committee of the House of Commons, Hon. A. T. Galt, Chairman, reported, among other things; "It appears from the evidence that settlement has been unreasonably pushed in some localities quite unfit to become the permanent residence of an agricultural population. Especially has this been the case in some of the Free Grant roads and adjacent country, lying between the waters of the Ottawa and Lake Ontario. Your Committee would refer to the evidence and recommend that the Government should, in all cases, ascertain positively the character of the country before throwing open any tract of land for settlement, so that such lands that are really not fit for profitable cultivation may not be thrown upon the market."

Again, in 1865, the Hon. A. Campbell, Commissioner of Crown Lands, in his report for that year, stated: "Though much of it (the pine country) has been denuded of its valuable timber, it is the opinion of the best informed, that a large area remains untouched; happily for the interests of the country, the pine exists on lands for the most part unfit for settlement. It needs a careful discrimination between the pine lands exclusively and lands fit for settlement, to place it in the power of the Government to conserve this valuable source of national wealth. Should the whole of our uncultivable land be set apart, as I think should be done, as a pine region, and no sales made there, the land would, if the trees were cut under a system of rotation such as is now adopted in Norway and Sweden and in many of the German states, recuperate their growth of merchantable pine in cycles of 30 and 40 years, and pine growing might be continued and preserved for ages to come. In view of the future requirements of this continent and of Europe, and of the singular advantages that Canada enjoys as a pine producing country, I humbly submit that it is of the utmost importance that we should now take steps in this direction."

If the warnings of such men had been heeded it would have been better for the prosperity of Ontario, and I beg to add Canada.

The same conditions exist in a more or less agravated form from Nova Scotia to British Columbia. To my own knowledge within 25 miles of Toronto and 10 miles of Ottawa are areas where settlers are doing their best to win a living for themselves and families from sterile lands that were never intended to be used for agricultural purposes.

One Surveyor reports that he counted 20 abandoned homesteads in one township during the summer of 1920. From portions of Southern Saskatchewan and Alberta, many settlers are appealing for assistance, being faced with starvation, owing to the nature of the soils they have been trying to farm. In a recent trip to Northern Alberta many abandoned places were noted, and the usual trouble was their want of knowledge of the soils that were to be farmed and no doubt there are many examples of the same kind in the United States. There are literally tens of thousands of people who have spent or are spending their hard earned all to try to have a home of their own and become good citizens but who as a matter of fact have not a chance to succeed owing to the quality of the soil upon which they have located, but why prolong the string of evidence? A successful, prosperous, well fed man is as a rule a contented and useful citizen, while the disappointed and starved, is discontented and dangerous, a menace to the community and a direct

economic loss to the country. These examples would serve to provide the *raison d'etre* why we should have soil surveys.

The Classification of Lands and Soil Surveys are the sure and real foundation upon which to build our agricultural superstructure. No haphazard policy will do. Our New Minister of Immigration and Colonization has declared, "That the Government's duty was not done when the immigrant was landed here, he should be followed and provided for until he became a Canadian citizen in the truest sense of the word"--with that declaration before us and the knowledge that the very first condition for the settlers' success is that he must have suitable land in a suitable locality--the necessity for a comprehensive knowledge of the localities and the soils of those localities where would be settlers may find the land they desire would seem to be most obvious.

May I be permitted to tell you something of our beginnings and what we are trying to do. In the winter of 1917-18 the newly formed *Soldier Settlement Commission* apealed to the Surveyor General for information regarding Crown Lands that were available and suitable for the purpose of locating returned soldiers who wished to farm. The most promising tracts were investigated during the summer of 1918 acting on instructions hurriedly prepared and incomplete. In one area in the Peace River 17,000 quarter sections were investigated and of this number eleven hundred were classed as available and suitable for immediate settlement. An index map showing this information was issued in March 1919 and before the end of the year 1,000 quarters had been entered upon. Do the public appreciate such maps? Is such work a service that is required? It is suggested that the rapid taking up of this land is the answer, and I have further to add that 80% of these people are making good.

I could go on and tell you of similar experiences in the Porcupine Forest Reserve and other places, clearly indicating the strong and reasonable demand, that Government should be able to give all manner of necessary detailed information regarding lands to the prospective settler and not leave him to the tender mercies of land offices and land agents, land locaters, who, as a rule, have little more knowledge than himself, while to ask the immigrant to choose his own homestead, without the information obtained by land classification and Soil Survey, is to ask him to expend his probably scanty capital on a search that may very possibly prove fruitless.

The Controller of Surveys under the direction of the Surveyor General was given charge of this work and quickly saw that the possibilities for assisting in an attempt to direct settlers to the best of our lands were very great indeed. At the same time, the importance of a comprehensive knowledge of our soils was made so clear that the matter of land classification and soils surveys was at once put under way. Instructions were prepared in greater detail for use of men in the field. A course of lectures on soils was arranged for, and delivered to the Surveyors who were allowed two hours per week during office hours for this purpose, a laboratory to carry on the physical analysis of soils was opened and Surveyors were directed to send in samples of the different soil types in the areas in which they were working. The result has been that in several areas we have turned out classification maps that give most comprehensive information as to the cost of clearing, accessibility, agricultural possibilities, water, roads, contours, etc., etc., and are hoping very shortly to try our prentice; land on soil maps, as during the past season several of the surveyors have compiled most creditable field copies.

Our laboratory was moved to Saskatoon during the past summer and four Surveyors are now there studying soils under the capable and efficient direction of Professor Hansen of the University of Saskatchewan, and we are laying plans so that the Federal and Provincial authorities may co-operate in carrying out this vitally important work.

In this same connection the Controller of Surveys not only proposes to provide information regarding lands available and suitable for immediate settlement, but also to prepare areas where the land was suitable, but the expense of clearing prohibitive, so that they would be immediately suitable for settlement, and with this end in view he adopted the policy of the "Scientific clearing of lands by fire".

This scheme was successfully inaugurated in the spring of 1919 when some 20,000 acres were cleared at a cost of about nine cents per acre. In the spring of 1920 the experiment was not as successful as could be wished for, on account of the weather conditions, but still some 20,000 acres were vastly improved at a very low cost, and in 1921 some 100,000 acres were cleared by fire at a cost of seven cents per acre. Let me make this quite clear. The land is not entirely cleared, but so much of the detritus such as windfall, burnt standing timber and small green brush is destroyed that at the small expenditure of $2.00 per acre, or less, large areas are made ready for the plow and at a material saving of both time and money.

It is to be observed that an examination of the soils both before and after these carefully planned burnings, discloses the fact that they were not injured in the least from the Agricultural point of view, the reason being that the ground is carefully watched and when grass and small brush is dry, but before the drying effect has reached the soil, which is still moist from the effects of the winter snow and frost the fire is started. Fire Guards, of course, are most carefully planned and laid down so that the area to be burned is always under control. This area is selected the previous season and as soon as the snow is sufficiently melted preparations are put under way.

Clearing of lands by controlled fires was dealt with and explained in detail by Mr. F. V. Seibert, D.L.S., in a paper presented at the Annual Meeting of the Dominion Land Surveyors held in Ottawa in February, 1920, and in discussing the paper the Controller of Surveys made the remark relating to fires, "Whether or not you approve, you are going to have fires. You have it today and you will have it in the future. The events of the past year should convince any one of that. They were fighting fires from one end of the country to the other. Behind the whole firing scheme you have the clearing of land and protection of timber. Find out what you want to do, then carry out your protection."

The subject of firing is mentioned at some length as it is desired to draw attention to land classification, the lands' preparation for farming, as well as soil surveys, it being the intention to use them together in our work on Crown Lands. As our Classification work is to date being carried on with a view to a more systematic and reasonable Colonization policy being adopted our surveyors are mapping lands having regard to the clearing, the Soil and topographical features. This enables the Department to present a map giving the settler fairly comprehensive information regarding any section of the country that has been mapped.

If the lands are considered suitable for agriculture, the amount and character of the clearing necessary for the settler to begin cultivation is estimated. The grazing lands, timber, marsh, and swamp lands are clearly shown. The principal Soil types are marked on the soil map in terms readily understood. This together with the report is to be made available to the proposed settler and also to those Departments of Government who are assisting in his settlement.

To the present time in our Soil work we have decided on no system of nomenclature other than sand, sandy loam, clay, clay loam, etc., but already names appropriate are suggesting themselves when the difference in soils from different localities but of the same class are examined. It is proposed however to report on color, texture, structure, organic content, acid, alkaline or neutral, together with a comprehensive description of the natural vegetation.

Through our co-operation with the Agricultural Colleges our men are to be trained in Soils and we hope to be able to induce graduates and undergraduates to assist in our work, and we propose to be able to indicate on our maps and reports which we hope later on will be issued jointly by the Dominion and Province, what crops the lands are best suited for, what treatment those lands should have to produce the best crops, through information at the present time being gathered by the Agricultural College. It is proposed, so far as is possible, to leave nothing to chance. If the settler is intelligent, industrious and willing, we shall see to it that the land he chooses will do its part, weather permitting, and lands not suitable for farming will be indicated so plainly and clearly as to prevent their being chosen for that purpose, so that the chances of failure by reason of the land shall be reduced to a minimum.

Any great and useful movement to be a success must have a sound ethical foundation, no other conditions matter, or can take the place, of this foundation upon which such a structure as we are proposing is to be built. Therefore, I say that our first care must be for the welfare, comfort and happiness of the individual. Other conditions may prevail and seem to succeed for a time, but history has shown that no other foundation than the Golden Rule is permanent. Let us, therefore, in all our work strive to put that into it that is going to result in lasting benefit to humanity.

Just a word on the ethical side of Land Classification and Soil Surveys:-

As has been pointed out, the want of knowledge and planning has been the cause of most of disappointment and failure in agriculture. We are in too great a hurry to accumulate dollars. We exploit the land as well as our other natural resources, instead of develop them.

The injunction to "Do unto others as you would that they should do to you" imposes several obligations upon us and among them is the one that those who desire to become citizens shall know the land. Land Classification and Soil Surveys determine the constructive disposition of land in use and development and are the genesis of production.

The first law of nature "Self preservation" demands a comprehensive, accurate, knowledge of the lands and soils, so that effort may not be wasted; in other words, we must apply the rule "Conservation of Energy."

Soil Survey workers are post-graduates seeking to shed the light of their

professional research upon the problems of agricultural betterment. The slum must be abolished and the isolation of the farm is quite as deliterous to the proper advancement of man as is the congested tenement.

If ethics be those customs of righteousness that have become so, of necessity for survival in the evolution of the race, then we must will their progressive continuity or be engulfed in social degeneration. Spiritual and moral strength cannot thrive upon physical degradation, nor can the health and efficiency of happiness, flourish upon poverty, disappointment, and wasted effort.

Ethics and economics are different yet indivisible manifestations of the fundamentals of natural law, directed towards the enhancement of human life, to its happiness and its conservation. Together they make for prosperity. Divided as they are in much of our patchwork commercial systems of the present day, they lead to disaster.

The economics of the Soil Survey and Land Classification, is the science of the conversion and the conservation of energy, in the maintenance of life. What does it all mean--very shortly and clearly--no human energy must be wasted trying to cultivate sterile and unsuitable lands.

Lands most suitable for aforestation will be used for that purpose alone; grazing lands set aside for that purpose; agricultural lands will be clearly defined and classified, but the work should not end here. The arbitrary system of rectangular farms without attention or thought being paid to topographical or soil type features is most wasteful and extravagant.

We have too many road allowances and too few roads. While it is probably next to impossible to plan settled areas, in districts such as we have in Canada, many new areas could be planned to cut out waste of land, unnecessary roads, cut down fence mileage, in other words, substitute a planned settlement for a haphazard one. For this work, as stated before, land classification and soil surveys form the sure and unmoveable foundation upon which to build and the more information and knowledge we can acquire and make public regarding soils, the greater benefit we shall confer upon our fellows, and incidentally upon ourselves.

THE SOIL SURVEY REPORT

By W.T.Carter, Jr., In Charge Texas Cooperative Soil Survey.

The soil survey report should be a complete account of all findings and observations made during the course of mapping the soils of an area. Of course the report should include only the more important results and not necessarily many of the minor or more obvious features. The report should be written in such a way as to be easily read and understood by the layman or man of ordinary education in order that the results of the work shall have the widest application and be of value to the largest number of people possible.

I often hear the criticism made of government publications that they are too technical and the terminology employed is such that only people of technical training can understand them. It seems to me that this criticism is not a wholly just one for the soil survey reports as published by the Bureau of Soils. It seems that these reports are written in such a style that almost everyone can understand the results of the work provided there is an interest sufficient to cause them to make only the slightest study of the soil survey report and maps. We should also remember that it is not always feasible to go into extreme simplicity at the risk of leaving out some important material. While the patient can be improved by placing a sugar coating on his medicine and thereby making it more palatable and therefore more eagerly taken we should not exaggerate the saccharine constituents else he will demand all sugar with a minimum of effort on his own part to improve himself by his own study.

The report to have its widest use and application should be attractive, however, and should, if possible, have the quality of drawing attention and interest. I know of no better way than to have some illustrations. It is a well known fact among publishers that an illustrated article will be more widely read than one not illustrated, and doubtless the popularity of some of our large magazines is largely due to the excellent illustrations they carry. The pictures in a report also carry a point more quickly and it impresses it more firmly than the mere reading.

Now as to writing a report it seems to me, through observation and experience that it is one of the most dreaded parts of soil survey work. This is the wrong viewpoint and really it should be looked forward to with enthusiasm by the soil survey worker. It gives him the opportunity to record all his work and shows what he has found of value during the course of his field work. However the dread of the work is largely due to apprehension, I believe, owing to his fear that he has not secured sufficient data to write a good report. Soil survey work involves considerable physical labor and this inducing fatigue places the field man at night in the most unfavorable condition for writing or thinking--and there are long periods of time when his only time for working on his data for the report is at night. As a matter of fact it is not surprising that he finds the season far advanced or the area nearly complete before he has gotten much of his report in shape when we consider that the greatest ideas along scientific and literary lines have never been produced by those who toil physically.

The soil survey worker as a rule is extremely interested in getting his

field work as accurate as possible and his soil map in the best possible shape, all by a certain fairly definite date. His mind is on the details of field work all day and sometimes for much of the time at night or at other times when not doing actual field work. This is more especially true in the southern and western states where in most areas it is necessary to construct a base map, and where therefore a great deal of the field mans time is taken up in the field with work not entirely connected with a strict examination of the soils. He gets rushed for time and in endeavoring to make a good showing of field work accomplished he fails to take notes as fully as should be done. Then when the field work is completed he starts his report and endeavors to get it off his hands as soon as possible as there is usually urgent need to proceed at once to another area to start new work. After a field man starts his report he finds that for the first few days, in many cases, he can get little done. Theoretically all he has to do is to sit down and write up the results of his investigations for the season. However he is in the throes of a pschycological change--his mind is being wrested from the details of field work and made to accommodate itself to work of an entirely different character. His intellectual or literary mind is in low gear with the breaks on. This continues for two or three days when finally he finds himself able to write a little and makes some progress with his report. This may be termed second speed which soon gives way to high speed when he finds he is able to open the throttle, and writing day and night he finishes the report in a blaze of energy with his senses alert and his mind hitting on all cylinders. Just at this time he should be starting his report instead of finishing it.

Necessarily all soil reports must have an outline or plan in order to be consistent. This has been worked out to a highly efficient degree. While this is proper it places a barrier to some extent to initiative work. Often it seems that all that is necessary is to simply write coherently the report following the outline. Knowing that the work will be corrected by a competent editor not a great deal of attention is given to correct composition. I feel that this is an unfortunate thing for I believe those in charge of soil survey work would welcome any improvements in the soil survey report that the field man could suggest provided the suggestions were really valuable.

Theoretically, we can sit down and plan how the report should be gotten up by the field man. He himself can plan just how he should do it and then find when he gets in the field that his good plans go awry. Certainly nothing should prevent him from taking very complete notes, and yet speaking for myself I find that I am frequently guilty of being remiss in this point. I believe a field man should stop when the field work for the area has been partly completed, for several days, or a week, and write up a number of his chapters on soil types. He should stop occasionally and take time to revise and to get everything of interest and value about the soil types so that when field work is concluded his soil types are practically all written up in the best style possible. Then he should rewrite the chapters on soil types and make them as complete as possible.

DISCUSSION OF SOIL SURVEY REPORTS.

By A.T.Wiancko, Chief in Soils & Crops, Purdue University, Lafayette, Indiana.

My only purpose in entering this discussion regarding soil survey reports is to raise the question of the possibility of the Bureau of Soils and the co-operating state agency issuing joint county soil survey reports that will be of more direct value to the farmers of the county than the report now issued by the Bureau, which, besides the technical description of the soil types found in the county and a general description of the area and its agricultural conditions, contains very little that is helpful to the man who is farming the land. Should the present form of this report be continued, or should it be made to include a discussion of the practical problems to be met in the management of each of the soil types with instructions regarding profitable treatments? As it now stands, the report is generally criticised as failing to meet the needs of the farmer. Some of the state experiment stations have met the needs of the farmer by taking the descriptive report of the Bureau and combining with it a practical discussion of the management of the several soils, including suggestions regarding soil treatment, systems of cropping, etc., and issuing this as a separate and additional report. Is such a separate report necessary or desirable?

In states where the Agricultural Experiment Station and the Bureau of Soils are co-operating in soil survey work, it seems to me there should be some way of making the report serve the purposes of both the Bureau and the Station, and that it should not be necessary for the two agencies to publish separate reports, as is being done in several cases. One difficulty seems to be the matter of credit, the kind of cover to use and what should be printed on the outside. Would it not be possible to devise a cover and form of statement showing the co-operative relation in the work that would be acceptable to both the Bureau and the state agency? The other difficulty relates to what shall be included in the report other than a general description of the area and the scientific description of the soils. The Bureau seems to be satisfied with the descriptive report, with here and there a word regarding some practical phase of soil management, while the stations would like to include a rather full discussion of the practical management of the several soil types, including data from experiment fields where such exist, either in the area or on the same soil type in some other county in the vicinity. I think it is generally agreed that the latter would add materially to the value of the report, but no such combined report has yet been published, except as a separate report published by the state agency. Perhaps a committee of this association could help solve these difficulties. In any such combined report, I believe the Bureau of Soils should govern as regards soil classification and scientific description, and that the State Experiment Station should determine what is to be said regarding soil management and the recommendations that are to be made because this institution is most likely to have the best information upon which to base practical suggestions that will be helpful to the farmer. Would not such a combined report serve the purposes of all concerned, and save duplication?

December 3, 1921.

Mr. W. J. Geib, Secretary
American Assn. of Soil Survey Workers
Madison, Wisconsin.

Dear Mr. Geib:

* * *

I am very sorry that it was not possible for me to be at your meeting held in Lansing. The fact is that I was quite sick at the time this meeting was held and could not think of trying to make the trip. * * *

What I intended to do was to speak of a progress or a preliminary report written especially for farmers, the need for the inclusion of better illustrative material and for the working out also of other visual material based on the survey and for use by County Agricultural Agents and schools. If we would do these things, the survey could be described even more technically as a contribution to knowledge and as a working basis for not only the farmers but for road work and otherlines as well.

There are those who feel that the soil survey report should be written nearly wholly for farmers. This, as I see it, would be a wrong move because the survey stands for broader relations than agriculture but we should not overlook the needs of the farmer and should endeavor to make known the results of the survey to the farmer so that he may understand the work and the results of the work. * * *

Some of our reports include too much material that belongs more to Geological Survey, Hydrographic Survey and otherdivisions than to the soil survey and this seems to be caused by the fact that some of the men have been trained in those lines and because they have not yet gained the proper attitude and approach for the soil survey work proper. It is not necessary to use all of the geological survey names and to compile a nomenclature that cannot be understood by the average reader or that is not appropriate for the purposes of soil survey descriptions.

Wishing the Association of Soil Survey Workers success and hoping that I may be in a position later to assist in furthering this cause, I am

Very truly yours,

(Signed) G. E. Condra,

Director,Conservation and Survey Division,
University of Nebraska.

SOIL SURVEY PROBLEMS OF THE CANADIAN WEST.

By Roy P. Hansen, Prof. Soils and Crops, University of Saskatchewan.

While I was called upon to speak to you on Soil Survey Problems of the Canadian West, I intend to confine my remarks particularly to conditions in Saskatchewan, the central of the three Prairie Provinces of Western Canada. Agricultural conditions are very much alike in Alberta, Manitoba and Saskatchewan, so that most of what I have to say will apply equally to the three provinces.

It is astonishing how little the conditions, both climatic and agricultural, of our Prairie Provinces are understood by the people to the South of us. Soil survey problems with us are the result of our peculiar conditions, and in order, therefore, to present these problems to you, it will be necessary that you understand something of those conditions.

The Province of Saskatchewan extends from the 49th to the 60th parallel, the states of Minnesota and North Dakota being immediately to the South. The area is 251,706 square miles, equal almost to that of Texas. Of this the Department of the Interior has calculated that 94,000,000 acres are suitable for agricultural purposes, though this appears to be a somewhat liberal estimate. The cultivable area is estimated at about 58 to 60 million acres or a little over one and a half times the total land area of Michigan. Of this 58 to 60 millions of acres, only 23 millions are at present under cultivation.

The great bulk of our cultivable land consists of open prairie similar in all respects to the Great Plains Region, of which indeed it is but a continuation. Immediately north of the prairie is a narrow strip, 70 to 100 miles wide, known as the Park Belt, so called because it resembles a park. The prairie is here interrupted with scattered poplar scrub and bluff, but most of the land can be brought under cultivation without much clearing. North of the Park Belt lies the forested areas, the trees consisting mainly of poplar and some tamarack, and farther north the jack pine, spruce and balsam.

The total precipitation varies in the province from about 13 inches to 21 inches, with a general average of 15 to 16 inches. The driest part is believed to be the south-west corner; actual averages show the area between Medicine Hat and Lethbridge in Alberta to be the driest area in Western Canada and the average annual rainfall increases in all directions from this centre. At Winnipeg, for example, the rainfall is 17 to 19 inches. The northerly portions of the province of Saskatchewan may show some increase in precipitation over the southerly parts, but the factors of hot winds and evaporation probably are actually more important from the standpoint of crop production.

The growing season in the north is three or four weeks shorter than in the south. For example, the average length of season as measured by 3° of frost at Prince Albert is 117 days, as compared with 152 days at Maple Creek.

Wheat seeding is general in the average season during the last week in April, and wheat comes to maturity about the middle of August--at Saskatoon August 18th. Wheat requires a season of 100 to 110 days, depending upon the variety and other conditions; oats require 90 to 95 days.

Sufficient to say, the normal rainfall is enough to produce abundant crops, providing we get the average amount, and providing the distribution is normal. Likewise, the growing season is long enough, providing the season is normal. As regards both precipitation and growing season, conditions are ideal for the production of spring wheat, or, I might say, spring grains, to include oats, barley and flax. As evidence of the quality of our spring grains, I need only refer you to the prizes in spring grains at the International Show that have fallen to the Prairie Provinces. In 1919 Saskatchewan alone won the first six places in wheat, including sweepstakes, and in all 14 prizes out of the 25 offered. Last year we again captured the sweepstakes. The Prairie Provinces have been prominent winners with oats and barley, as well as with wheat. Last year, first in oats fell to Alberta.

It so happens that 50 to 60 per cent of the precipitation falls during the months of May, June, July and August, in other words, the growing season when the moisture is most needed. The fall season is normally dry, facilitating the harvest and producing an excellent quality. In 1920 wheat production in Saskatchewan amounted to 113,135,000 bushels, oats 141,549,000 bushels. Estimated production for 1921 for wheat is 174,400,000 bushels and oats 181,724,000 bushels, with an average yield of 14.9 bushels per acre for wheat and 37.2 bushels per acre for oats.

With this somewhat lengthy introduction, I turn to our problems.

Owing to a combination of circumstances, some natural and unavoidable and some resulting from our present system of farming, agriculture in some parts of the province has been unprofitable and unsatisfactory. In the first instance ours is and has been in the past a one-crop system of farming. As already pointed out, our conditions are ideal for the production of spring grains. The market demands and better price for wheat has made Saskatchewan a spring wheat country. Owing to insufficient moisture to produce a crop every year, the practice of the bare summerfallow is general. The common plan or rotation, if it may be called such, is summerfallow followed by two crops of wheat. Oats sometimes replace wheat as the second crop, though oats are grown mostly for home consumption. In some districts however, the acreage devoted to oats approaches or exceeds that of wheat. It is hardly necessary for me to point out the hazards of such a system. It was a necessary evil for our early settlers since, for the most part, they lacked the cash to do otherwise. Now that the system is established, it is very difficult to remedy it. The cure, as you can readily see, consists of diversified farming and crop rotation, but this is difficult to bring about as it is one thing to suggest a remedy and quite another to put it into practice. In Canada, as perhaps may be true elsewhere, the farmers do not always do everything that we may advise, which is sometimes very fortunate for our agricultural industry.

Our second difficulty is drought and this has been more marked owing to the first fault, the one-crop system. Particularly in the far south-west corner, the years since 1915 and 1916 have been dry ones. Some districts have experienced four or five successive failures, owing to lack of moisture. Perhaps I should not say drought, as some of these years showed an average annual precipitation, but the distribution was such that spring grains were a failure, and as nothing but spring grains were seeded, the results were disastrous. In some instances the rainfall was decidedly subnormal, but this is a hazard of all dry farming areas. But the danger of drought can be in a great measure overcome by proper rotations, which enable the moisture to be utilized to best advantage when the distribution is abnormal. For example, at Saskatoon we have

found that fall and spring rains insure crops of grasses, alfalfa, sweet clover, and perhaps the intertilled crops. Given the normal distribution of rainfall our spring grains yield well. Late rains give us harvests of hay, corn, forage, sunflowers and roots. In other words, we feel that with proper rotations which spread the risk, we need not suffer from drought, except in seasons of decidedly subnormal precipitation.

A third source of concern is the problem of soil drifting. This is the result of the dissipation of organic matter from our soils, assisted by our light rainfall, prevailing high winds in the early spring, and exposure of large acreages of bare summer fallow. The difficulty is not so serious except on lighter soils, but is likely to become more serious as time goes on. Here again the problem is one of educating the farmer into the practice of crop rotations and proper methods of soil management.

A second factor related indirectly at least to profitable farming, is the question of land settlement. In our settled areas the cheapness, the level or gently undulating topography, and the ease with which large areas may be brought under cultivation has lead to an extensive type of farming. Not that all large farms are mismanaged, but the tendency is in that direction. Our farmers generally attempt to work more land than they can properly handle, and frequently--perhaps I should say very commonly--the land is abused. Smaller farms and better management are inevitable. There is room for thousands of new settlers in our already settled areas.

Associated with this question, is the question of unoccupied land. The Intelligence Branch of the Department of the Interior by investigation found in our settled areas about 10 millions of acres of land unoccupied. This land is held chiefly by speculators in the United States and Canada, by the Canadian Pacific and Canadian National Railways and by the Hudsons Bay Co. More intensive settlement in the settled areas would assist materially as it would bring the markets closer to the farmers and assist in the many ways familiar to us all.

The problem of lands open for homesteading has been covered in a previous paper and I need add only a word. So far as Saskatchewan is concerned, the land available for homesteading has now been pretty well picked over. The difficulties with such lands are, cost and time of clearing, distance from market and, as is especially the case in the far north, inferior soil. The prospective homesteader should pick his land carefully and the land classification conducted in the north country by the Department of the Interior should assist him in his choice, or at least warn him of inferior land. The Provincial Soil Survey will confine its efforts for the present at least to the settled areas.

The Provincial Soil Survey in Saskatchewan was the outcome of a meeting of agricultural representatives called by the Minister of Agriculture. This meeting was held in June of 1920 at Swift Current, a city in south-western Saskatchewan, where conditions had been unusually severe. The actual work was begun last spring, when we began operations with one field party. Our method was somewhat between the reconnoissance and the detailed survey. We did not undertake a preliminary reconnoissance, and whether this was wise or unwise, I am not in a position to say. Since our agriculture is and will always be extensive in scale, we felt that a detailed survey was not necessary. We compromised, therefore, by travelling the roads north and south, one mile apart, and some of the east-west roads where necessary. Practically all of our work was done from the car. Our difficulties have been several. We lacked a laboratory

for analytical work, and this need has only recently been filled. We lacked trained assistants, both in the field and laboratory. I had two students with me in the field. This is all we had to start with. We spent three months in the field and were then driven in by a snow-storm. By the time the roads became again passable, the University had opened and no further work was attempted. But the season's experience was worth a great deal, and we hope to renew our efforts next year, better equipped and more completely manned.

I might also add that geological information upon which to base our work is lacking. Geological surveys, such as have been conducted in the various states, have not as yet been attempted in the Prairie Provinces.

However, with all the faults of commission and omission we plan to go ahead. We seek practical results; our main effort shall be to direct agricultural practice into more profitable and permanent channels. It seems hardly necessary to enlarge upon this. The little booklet on the Value of a Soil Survey, published by this Association, covers this very well.

Purposely I have not gone into detail regarding soil problems, because this is uncertain ground. Not enough work has been done as yet to reach any definite conclusions. The soil survey, it is hoped, will open up these problems and assist in their solution.

It is planned to follow up the survey with experimental work. We have already an established experimental farm in connection with the University. We hope at some future time to establish substations to represent the various conditions of soil, climate, etc.

The county agent movement has not begun in Saskatchewan but it is a probable development of the near future. The relation of these things to the soil survey is obvious to the people here assembled.

In summing up I want to point out that our problems come under two heads: first, to advise and to encourage systems of farming which reduce to a minimum the hazards of our present system (this of course is a problem of tremendous proportions, since it effects all phases of all agricultural activity); and second, to encourage settlement and development of our unoccupied land, not by misrepresentation but by the setting down of actual facts and conditions.

SOIL SURVEY PROBLEMS OF EASTERN UNITED STATES.

By Austin L. Patrick, Pennsylvania Soil Survey.

The topic has been assumed to include the following states: Maryland, Delaware, New Jersey, Pennsylvania, New York and the New England States. This group of states, taking them as a whole, are not pushing soil survey work as it is being pushed in many other sections of the country east of the Great Plains. The New England States are doing less work than the North Atlantic States, though Rhode Island was completely mapped in 1903. In preparing this paper, I have tried to divide it into two parts. Part I deals with possible reasons for the apparent lack of interest in soil survey work, as manifested by the amount of work done. Part II deals with local soil survey problems. Realizing that the subject is a large one, the opinions of persons in touch with, or interested in, soil survey work in Delaware, Maryland, New Jersey, New York, Connecticut and Massachusetts have been solicited.

Part I.

In reply to a letter requesting reasons for apparent lack of interest in soil survey work in the New England States, and especially in Massachusetts, Prof. Haskell, Director of the Massachusetts Agricultural Experiment Station writes as follows:

"I am interested in your letter of October 19, for, while it is some years since I have been actively and personally interested in soil survey work, yet I think I have always had an appreciation of the possible value of this work to the agriculture of the country. This letter, however, must be taken as stating impressions rather than proving facts.

I look upon the soil survey as being in the main a tool, the use of which is the evaluation of soils. The fact that soil and soil fertility workers in New England are typically unenthusiastic over this tool must have its basis on lack of satisfactory experience in using the same. There has been sufficient work done in New England, I believe, to warrant our fertility workers in passing judgment on the usefulness of the surveys as at present carried out. I wonder, therefore, if the most productive line of thought may not be to attempt to find the reasons for the apparent failure of the tool when used in New England, as compared to the generally favorable and unquestionable success of its use in most other parts of the country?

I must admit that I have not thought out the matter at all clearly, but submit below several suggestions which may be of value:

1. The difficulty may be due to the reputed inherent conservatism of New Englanders. Opposed to this, however, is the fact that in three out of six states the head of that department having to do with soils and soil fertility is from the Middle West. I refer, of course, to Professor Simmons of Maine, to Professor Taylor of New Hampshire and to Professor Slate of Connecticut.

2. Another disturbing influence may be due to the fact that in addition to the geological origin and textural properties, factors at the basic of all soil classification, we have in New England the enormously important factor of

three centuries of previous use. This certainly affects the tillage problem, it influences the fertility problem, it may even have some effect on the great problem of crop adaptability. It is so intangible as to be almost irreducible to terms of soil survey values.

3. A large part of New England consists of more or less raw glacial till, always reworked somewhat by later agencies. This is the most difficult kind of soil to reduce to survey values.

4. The humidity of New England climate produces local variations in drainage and organic matter (as modified by drainage) which have rather great influences on crops, but are difficult to classify in any worth-while way.

5. The small units in which the land is worked may have a depressing effect on the appreciation with which the soil survey is viewed.

As an illustration of the difficulty let me state a fertility problem which we have at this institution. We have two acre fields, each sub-divided into a number of smaller plots, lying about 250 yards one from the other. The whole of this would come inside of a single field of approximately eight acres were the land divided and farmed under normal conditions. For one of these fields, we have an experimental record of thirty-three years, the other in the neighborhood of twenty-four years. In both cases the layout of the experiment allows of clear measurement as to the effect of potash. In one case, as measured by the average of some thirteen different corn crops, the influence of potash has increased the corn crop by about 22 bushels per acre. In the other case, as measured by an average of some six corn crops the influence of the potash is in the neighborhood of 1/2 bushel per acre increase. And yet, on the soil survey map prepared some twenty-three years ago, both of these soils are classified together.

I cannot resist the temptation to enlarge a bit upon this illustration. In second field, that giving practically no response to the use of potash, there are five check plots, with potash-treated plots on either side. Otherwise the treatments are the same. Within the last five years there has come about a change in behavior on these plots, however, so at the present time two out of the five check plots indicate rather marked increases of potash on the adjacent potash-treated plots. Here we have not only marked differences inside of an eight-acre unit, but likewise differences inside of a one-acre unit. I wonder if this does not indicate that our basis of final soil classification must be somehow different from that now utilized?

After all, however, I am merely attempting to think out loud and then reduce my meanderings to written form. What is really needed is for some resourceful student of the New England conditions to give entire attention to the problem of so modifying existing methods as to give full value of the soil survey tool as used under New England conditions.

Wishing for your meetings the very best success, and with personal regards, I am

Yours truly,

(Signed) Sidney B. Haskell

Director".

Speaking for Pennsylvania, I would say that lack of funds accounts for the small amount of work done in this state. The lack of funds for soil survey work is due to a great many factors, chief among which might be mentioned, lack of advertising, and general reluctance of the state legislature to appropriate money for the College in general.

Recently more interest is being taken in soil survey work in Pennsylvania. During the past season the State Geologist helped finance the work, and at a recent Agricultural Conference, Secretary of Agriculture Rasmussen laid great stress on the need for pushing this work. Perhaps brighter days are ahead.

Part II·

Under the heading entitled Local Problems, have received something from nearly every state. Professor A. G. McCall, of Maryland, says, "With the close of the present season, we will have finished all of the field work, with the exception of one county. Our most serious problem at the present time is in connection with the corrections that need to be made on the earlier surveys. The work was started in this State more than twenty years ago, hence several of the earlier maps are seriously in need of revision."

Prof. George L. Schuster, of the Delaware College, says, "Our problems in soil survey work are about over. Our field work has been completed and the material is now in the hands of the Bureau of Soils for publication. Our problem now is to get the publications out at an early date. It seems to take considerable time for the Federal Government to get these publications out after the field work is done. If there could be some manner of speeding up this end of the work, I think it would be of great value."

Mr. Leslie R. Smith, Secretary to Commissioner of Agriculture, of Massachusetts, replies in part as follows:

"Our soil survey work is going along very smoothly. We are cooperating with the United States Department of Agriculture, running one team in our State each year: that is, one man from that Department and this Department furnishing one man. This practice has now been carried on for three years, and we know of no reason why it should not continue until our State is covered.

So far as troubles are concerned, I don't know that we have any, except that the Department has not been able to get out our maps as fast as we would like them, but that will come very shortly now, I expect."

Mr. F. B. Howe, who is directly in charge of the soil survey work in New York State, brings out a number of problems. His letter is as follows:

"In reply to your request of October 19, 1921 relative to a statement concerning the problems of the New York State Soil Survey I may say that many of our so-called problems are more incidents connected with the work, many of which are perhaps imaginary, but nevertheless there are several matters which could be given consideration here. It is to be expected that progress in the work will bring forth many problems to be solved.

At the outset I wish to emphasize that we are firmly in favor of cooperating

with the Bureau of Soils, insofar as it permits the State to accumulate data on the soils that are accurate. Such relations with a cooperative agency naturally lead to the formation of mutual problems. The maintenance of a high standard of efficiency on the part of the State representatives and the Bureau men is necessary for the satisfactory solution of these problems. This leads to one universal problem connected with soil survey work; that is the difficulty of getting efficient, trained men.

In New York State we have approximately 1/2 of the State completed by detailed surveys. The question of selection of counties to be surveyed at times has been a perplexing problem, owing to the petitions and requests made upon us. In order to adopt a policy for future selection of counties to be surveyed that would guarantee the results desired, it was necessary that the selection of areas to be surveyed should be determined largely upon the apparent need for information regarding the character of the soils of certain areas, insofar as the knowledge accumulated may be related to the solution of soil problems involving the State as a whole. Our future policy is consequently conservative.

With a recognition of the necessity for accurate soil mapping and proper soil correlation in New York State, it is largely impressed upon us that careful inspection by an experienced man is absolutely imperative. It is becoming more apparent year after year that as the number of soil types increase and new series are continually being recognized that much more time should be given to an Inspector in an area. This time should be given in actual checking up and assisting the field men in the performance of their duties. It is to be expected that such a plan will permit the Inspector to gain a fuller knowledge of the character of work the various field men perform. It also holds that more time given by the Inspector in an area will tend to obviate the many questions that arise in regard to correlation. If necessary the number of areas visited by an Inspector should be reduced in order to permit more time given to an area.

One problem which I expect is common to all states and concerns us in New York State is the matter of Series names. Much care should be taken in selection of a series name in order that subsequent changes can be avoided. The name of a new series within a State which cannot be well correlated with any other series inside or outside of the State should be of local derivation rather than given a name of a series found in a widely separated area with which it does not well correlate. Such a plan naturally will mean a multiplicity of names, but will also mean a more permanent nomenclature of soils within the State.

One problem which concerns us very much is the difficulty encountered in correlating data obtained by chemical analysis and experimental work in other states on soils that are common to our state. Boundary lines are merely imaginary lines and it is worthy of mention here the obvious necessity of various states engaged in soil survey work to adopt uniform methods of sampling soils and uniform methods of study. One criticism directed towards our work has been the inability of State officials to correlate data obtained upon the same types located in widely separated areas. It naturally follows that many factors beyond the control of the field man enter into this difference of results, but it is expected that such disparity could be lessened if uniform methods in soil sampling were used and systematic methods in the follow-up work were carried out in detail and adhered to religously. A review of the methods and manner in which soils are sampled for subsequent study in the laboratory and in the greenhouse by various States indicate in a way an explanation for the wide differences in the results obtained and the inability to correlate the soils in question.

Extending to you my best wishes and hopes for a successful meeting of the Soil Survey Workers, I remain

Very truly yours,

(Signed) F. B. Howe

Soil Surveyor."

Mr. L. L. Lee, in charge of the New Jersey Soil Survey, tells how they have and are continuing to overcome many of the problems in his State:

"In regard to our "troubles" here in New Jersey Soil Survey, I've given this subject considerable thought since receiving your letter, but am almost at a loss to add further to those you seem to have over there. In fact, it hardly seems that we have that many. We have tried to meet each emergency as it came up, however, and perhaps our methods of doing this might prove of value in other States.

Chief among our difficulties has been in obtaining trained men and keeping them. Others might profit by our experiance in training students during the summer months for two or three years with the assurance of permanent employment upon graduation. Once having obtained a competent man sufficient compensation should be given him. The great difficulty of retaining men in the soil survey and for that matter in other lines of State and Government work has been in not making the position sufficiently attractive from the standpoint of compensation, with the result that the man is forced to accept other positions or enter other fields just when he has developed into a valuable soil man. We must recognize and meet this condition if the best men are to be retained in the work and one good man is worth several with one or two years experience. In the long run, money is saved by retaining the trained men.

The use of the soil survey reports is one of our greatest problems. Fundamentally, to be of practical value the knowledge acquired by the Soil Survey must reach the farmer and in such a way that he can get concrete results, i.e., improve his soil--learn to meet various soil conditions, and adapt hisfarm methods to his various soils, thus increasing crop yields and his income. In New Jersey, we are now inaugurating a campaign among the county agents by which each county agent will have on file and in his office the soil map of his county. But in order that he may understand and recognize these soils he must himself acquire that knowledge. We are, therefore, planning to send a field man of the Soil Survey to each county in turn and for a week or ten days take the county agent in the field and teach him the soilsof his county. He is then in a position to aid the farmer in his individual soil problems and at the same time educate the farmers as a whole in soils and soil problems by discussions at various farm meetings. This method might not be practical in every state, but I believe modifications of the idea could be profitably used elsewhere.

These are just a few ideas; others of less importance are (1) Speed up the publication of reports and soils maps; (2) Encourage the interest and co-operation of other agricultural agencies; (3) More publicity of the work in individual states and counties."

As intimated by Mr. L. L. Lee, Pennsylvania has a great many problems, but they nearly all hinge on the lack of money. We have trouble getting trained men. All of the assistants for many years have been young boys with little or no soil survey experience other than that obtained in courses given at the College.

Another problem we have had is the selection of counties to survey. We have attempted to choose those representing sections we knew very little about. Recently, we have decided not to map counties that do not have good base maps. Base maps are being made quite rapidly by the U. S. Geological Survey and the State Geological Survey and we feel that our limited funds will go farther if we do not attempt to make plane table surveys.

Pennsylvania is completely covered by a Reconnoissance Soil Survey, but series only were mapped and this has led to some confusion. County Agents, experimenters, and the faculty members of the School of Agriculture very seldom use type names, but refer to the series only as the Dekalb soils, Hagerstown Soils, etc., as though all of the types within each series were the same. Personally, I believe it is better to use types as the unit in the Reconnoissance survey rather than series.

Some of our minor troubles in the field seem to be due to the fact that the different inspectors have different ideas. For example, in Mercer County, Pennsylvania, which was mapped in 1917, the first bottom soils have been classed as Huntington and Holly, both of which are supposed, according to all previous work, to represent alluvial deposit from unglaciated limestone material usually mixed with some wash from Appalachian sandstone and shale material. Mercer County contains no limestone and is a glacial county. These and other similar errors seem to prove that the different inspectors are not in close touch with the work done outside of their own division. It shows the need of a man in each state who is familiar with the classification of that state.

Have attempted to show some of the soil survey problems in the eastern United States. We have many problems, but we believe the work is essentially right and that present day mapping is bound to increase the popularity of the work. Within the past year, many things seem to prove that the work is more popular than it ever has been with the people of this State.

SOIL SURVEY PROBLEMS OF THE SOUTHERN STATES

By J. F. Stroud, Alabama Department of Agriculture and Industries.

I deem it a special privilege to present for your consideration some of the problems connected with soil mapping in the south. I realize that practically all of you have had a much wider and more varied experience in the classification and mapping of soils than I, but I daresay that none of you have mapped more soils, that produce six bushels of corn per acre, which when converted into marketable form nets the farmer from sixty to one hundred and eighty dollars per acre. I refer to the numerous little manufacturing plants known as moon-shine distilleries.

The subject assigned to me for discussion is, "The Soil Survey Problems of the Southern States". I hope to call your attention to a few of the most salient problems with which a soil surveyor has to deal when making a soil map of an average county in the south. Those of you who are familiar with the soil conditions of both north and south readily recognize that the problems of making a survey in a coastal plain county in Alabama are entirely different from those encountered in mapping out the black fertile lands of one of your highly productive agricultural counties in the prairie states. In the first place the soil of the south are markedly different from those of the north by reason of origin, topography, climatic conditions, organic matter content, and many other factors.

The soils of the south have been formed through various agencies of rock disintegration, decomposition, and by the transportation of material and subsequent deposition. In the state of Alabama,--and I take this state as an example--there are a number of physiographic divisions, and in these, there are; according to the Bureau of Soils, five important and readily distinguishable soil provinces, or general soil divisions, viz: The Appalachian Mountains, Limestone Valleys and Uplands, Piedmont Plateau, Coastal Plain, and River Flood Plains. In these broad divisions, or soil groupings, there are more than 200 distinct soil types within the state.

The soils developed in each of these provinces are derived from different rocks and by different processes of soil formation. In the Appalachian Mountain Limestone Valleys and Uplands, and Piedmont Plateau provinces, the soils can be traced directly to the parent rocks, and the same physical and chemical characteristics exist in the soils as are revealed in the rocks from which they are derived. In many places in these provinces erosion has kept such close pace wit rock decomposition that the mantle of soil material is extremely shallow and in numerous instances a soil surveyor is unable to determine accurately whether he is dealing with a matured or finished soil, or fresh rock material. In the Coastal Plain region an entirely different condition exists; that is, we are dealing with materials which have been derived from rocks of the previously mentioned provinces, transported by water, deposited on the floor of the sea, elevated to various positions, and which have been subjected to oxidation, aeration, and influenced by both plant and animal life. The soils, developed on the second bottoms or terraces, represent the old overflowed material which is today undergoing changes through oxidation, aeration, etc. The soils of the first bottoms are constantly being changed by the addition of new material which is deposited during each overflow of the stream. Gentlemen, I think you will readily agree with me when I tell you the soil man mapping a county in the south has things,

other than a sweetheart, to attract his attention.

The soils of the south are decidedly deficient in organic matter or humus. This is probably due in a large measure to the fact that practically all of these lands supported a forest growth until reclaimed by the hand of man for agricultural purposes. There has been no opportunity for the soils to accumulate any great amount of organic matter like those prairie lands which supported a growth of grasses through centuries of time. Of course in the forested areas there is a superficial covering of vegetable matter, but this has not become thoroughly incorporated in the soil as a part of it and therefore, after a few years cultivation it passes away.

Another noticeable characteristic of the soils of the south is the absence of free carbonates, and practically none of these soils contain any large quantity of lime except those derived directly from the soft limestone, or calcareous chalk formations, which are of limited extent. It is true, however, that the parent rock from which many of our soils are derived contain lime, but in the process of soil formation this lime has not been allowed to accumulate in the soil or subsoil due to the heavy rainfall, the large amount of leaching , and the topography of the country.

The climatic conditions throughout the south are entirely different from those of the north and consequently the soils will naturally be affected as regards the leaching out of the soluble plant food. When the excessive rains are leaching the soils of the south during the winter months , the soils of the north are covered in snow, or frozen, and the soluble plant food contained in them is locked up to be fed to the coming crops. The heavy rains cause much erosion and gullying in many of our southern soils, and for this reason the texture and depth of the soils on many slopes are quite variable, hence come some of the difficulties of a soil man to know just the proper way to handle this condition.

The soils of the south with but few exceptions are prevailingly light in color, that is, they range from extensive areas of light gray, or grayish-brown soils to smaller areas of red to black colored soils. The black, or darker colored soils, comprise restricted areas confined largely to the prairie section of Texas, Mississippi, and Alabama, or represent what is known as the Houston, Trinity, Hyde,Portsmouth, Muck and Peat. The brown to red soils are developed in the Piedmont Plateau, Appalachian Mountains, Limestone Valleys and to some extent in the Coastal Plains. In riding through the Piedmont Plateau one is impressed with the different colors of soil ranging from gray, or yellowish-gray, to dark red, in the surface portion. Perhaps in a field of not over ten acres there may be seen a range of colors, thus giving it a very spotted appearance. In many places however in the south the colors, or shades of color, are quite distinct and little difficulty is experienced in mapping these soils, on the other hand, particularly in the Coastal Plains the contrast in colors are not always distinct and it is a question of judgment on the part of the soil surveyor to be able to say that a certain soil belongs to this or that series. This is particularly true where the Orangeburg soils, which have bright red subsoils, occur in close association with Ruston soils, which have dominantly yellowish red, to reddish-yellow subsoils. The same difficulty is experienced in the same localities in the separation of the Ruston from the Norfolk soils, which have yellow subsoils. There are times when certain types can be thrown in any one of several series and be correct in any of them. This condition is not due to the

general scheme of classification but to the diversity of detail within short distances. Except in the low flat seaward portion of the Coastal Plain, erosion has been sufficiently active in many places to expose the subsoil, and while this is a detriment to the land it enables the soil surveyor to determine the series or type; especially is this true in the Piedmont Plateau, Appalachian Mountains, and in the higher part of the Coastal Plains.

The soils of the south are dominantly sandy in the surface portion, the sand particles ranging in texture from fine to coarse. With the exception of an extensive area of silt loam developed in Mississippi, Louisiana, and Tennessee, and classed as Memphis silt loam, there are no other large areas of silt loam in the south. In the Appalachian Mountains, Limestone Valleys and Uplands, and Piedmont Plateau, the texture of the soils range from sandy loams through sandy clay loams to clay. In the Coastal Plains section the texture of the surface soil is mainly fine sand, loam, or sandy loam, or fine sandy loam. The fine textured sands are confined mainly to Florida and the seaward portion of the Atlantic Coastal Plain. Extending through central Texas, and in many places in the central part of the Coastal Plain east of the Mississippi, there are rather large bodies of heavy tough, waxy clays which comprise the Houston, Susquehanna, and Oktibbeha series. Unfortunately for the south there are no extensive areas of black, or brown loam, or silt loam, soils which are so well developed throughout the prairi regions. From the standpoint of texture alone the mapping of soils in the south would be a comparatively easy matter as it does not require much time for the average soil survey man to learn the textural differences in these soils, however, he is confronted with numerous other factors in determining classification. Topography may in some cases determine the classification of a type. Certain it is, that topography, irrespective of type determines to a controlling degree the reaction of the farmer to his surroundings.

The structure of the soils and more especially of the subsoils, in many localities, cause some difficulty in mapping. This structural difference existing in the subsoils has a direct bearing upon the agricultural value of the soil in its relation to thorough drainage, aeration, and capillarity. Some of our clay subsoils are almost identical in the amount of clay, silt, and sand, which they contain, but are markedly different in their structure; that is, they may be hard, compact, and brittle, on the one hand, and decidedly impervious, plasti and sticky on the other. There are, however, broad areas of soils, especially those in the coastal plains, which have friable sandy clay subsoils. It appears to me that the structure of the subsoil is one of the important factors to be considered in soil mapping because of its vital relationship to the agricultural value and methods employed in handling the soil. Much of the subsoil in the coastal plain section, (especially does this apply to the sandy soils) is so open and loose that fertilizers and manures are soon leached out and the crops receive no benefit from them after one or two years. This condition makes it necessary for the farmers to constantly apply fertilizers and manures in order to obtain satisfactory yields. Thus it should be borne in mind by every soil surveyor to carefully consider the structure of the soil, and subsoil in his field mapping.

Now, Gentlemen, I desire to call to your attention some of the problems in connection with the actual field mapping in the south. To begin with only a few counties have base maps sufficiently accurate upon which to locate the soils. To take an automobile and a good base map which you have in most of your northern counties and your system of roads, north, south, east, and west, on every section, and classify and plot thereon the soils, is an entirely different proposition from

starting out with a horse and buggy and a blank piece of paper on a plane-table board to make an accurate base map of a county in addition to mapping the soils. Those of you who are familiar with our southern conditions realize that it is much more difficult to accurately locate the soils on a map in one of our southern counties where only 30 to 50 % of the lands on the average farm are improved, than it is to make a map of one of the highly developed prairie counties. In tracing out soil boundaries and locating the small streams in the forested areas of cut-over lands, much difficulty is experienced and considerable time consumed. In only a comparatively few counties in the south have the public roads been improved to an extent where a person can advantageously use an automobile for soil mapping. In fact the roads in many of the counties have not been laid out in any definite system and they generally follow the lines of least resistance as regards topography and drainage. Again, the secondary roads, which are the only means of travel through many of the plantations, and forested areas, meander around in such a way and are in such bad repair that it requires considerable time to even drive over them, to say nothing about having to actually traverse them out and plot them on the map. You can readily realize that much greater progress, and in many cases much more satisfactory work can be done in one of the northern areas than in some of our southern counties. Soil survey men who work, say in Iowa or Nebraska, during the summer months and come south in the winter inform me that the mapping of from 4 to 6 square miles per day is not uncommon, while in the south, if a man maps two or three square miles per day he has done exceptionally well. Again, there is a mental satisfaction in mapping in an open country on a good base map while that satisfaction is seldom realized in mapping a wooded or partially developed area where a man has to devote a large part of his time to the making of a base map.

In order to make an accurate soil map, especially in our southern country, it is necessary that the soil survey man should possess certain qualifications, such as scientific training, good common sense or judgment, should be able to construct a base map and to readily recognize the slightest differences in soils. It has been my experience that men who were reared on the farm or who had come in close contact with farming operations, appear to adapt themselves to conditions more readily, and generally show an appreciation for the farmer, and are able to sympathize with him in his attempt to make a living and to improve his condition. In doing soil work in the south the surveyor comes in contact with the farmers and landowners who are interested in this work. These people frequently ask him numerous questions relative to the kind of fertilizers to use, the crops to which their soils are specially adapted and the best methods by which to handle these soils in order that their yields may be increased. The surveyor who is a practical man and who keeps himself informed along the lines of agriculture, and who knows the soils, and is able to answer the farmers questions, not only renders a service to the farmer, but instills in him the fact that the soil survey is an important and glorious work. Of course it is not possible for a soil man who is reared in one section or worked in a particular section of the country to be familiar with the soils and agriculture in all parts of the United States; therefore, it appears to me that after a man has had general experience with soils that he should be confined to one state, or rather definite localities, in order that he may become familiar with the soils and detailed agricultural conditions. With this knowledge he can better solve soil problems, make greater progress with the work, render better service to the Agricultural Colleges and Experiment Stations, make a more accurate soil map, and in fact be of more real value to the Bureau of Soils, or the state which he represents.

[illegible] out with a [illegible] and [illegible] a [illegible] sheet of paper on a plane-table [illegible] to make an accurate base map of a county is a problem in itself. [illegible] [illegible] the [illegible] [illegible] sometimes [illegible] such [illegible] difficult [illegible] [illegible] country [illegible] there only [illegible] of the [illegible] are improved. [illegible] it is to make [illegible] [illegible] [illegible] and [illegible] of one-acre fields, [illegible] only a compass [illegible] [illegible] granted to an [illegible] supplies. In fact [illegible] any definite system [illegible] chemical equipment [illegible] [illegible] of forest [illegible] covered in such a way [illegible] [illegible] that he [illegible] thing out and plot them on the map. You can readily realize that such greater [illegible], and in many cases much more [illegible] northern areas than in some of our southern counties. [illegible] only in [illegible] during the summer [illegible] interfere [illegible] while in the North, [illegible] exceptionally well. [illegible] country or a good [illegible] a [illegible] or partially developed area where a man has to devote a large part of his time to the making of a base map.

In order to make an accurate soil map, especially in our southern country, it is necessary that the soil surveyor should possess certain qualifications, aside from scientific training. Good common sense or judgment, should be said to [illegible] to readily recognize the [illegible] differences in soils. It has been my experience that the men who were reared on the farm and who had come in close contact with farming operations, [illegible] conditions more readily, and especially [illegible] for the farmer, [illegible] [illegible] [illegible]

and implement who are interested in this work. These people frequently ask him numerous questions relating to the kind of fertilizers to use, the crops to which their soils are especially adapted and the best methods by which to handle these soils in order that their yields may be increased. The surveyor who is a practical man and who keeps himself informed along the lines of agriculture, and who knows the soils, and is able to answer the farmers' questions, not only renders a service to the farmer, but instills in him the fact that the soil survey is an important and practical work. Of course it is not possible for a soil man to be reared in one section or engaged in a particular line of the [illegible] or be familiar with the soils and agriculture in all parts of the United States; therefore, it appears to me that after a man has had general training with soils that he should be confined to one place, or rather definite localities, in order that he may become familiar with the soils and detailed agricultural conditions. With this knowledge he can better handle soil problems, make greater progress with the work, render better service to the agricultural [illegible] and government stations, [illegible] [illegible] of the [illegible] in the state which he represents.

EARLY DEFINITION OF SOIL TYPES.

By F.J.Alway and P.R.McMiller, Department of Soils, University of Minnesota.

The real work of the soil surveyor in any area is to map, define and describe the soil types that are distinguishable. What he has mapped as one type may later, using finer criteria, be found to be properly devisable into two types, or the differences between what he regarded as two distinct types may prove so small and inconstant that they will be combined into one. Such things are to be regarded as a normal part of the work and not reflecting upon any of the workers. The naming of the types does not necessarily come within the field of the surveyor. In order to achieve a harmonious country-wide nomenclature it may even be passed up by the head of the state organization to a federal office without any reflection upon the knowledge or judgement of the state representatives. For the accuracy of the mapping or for most of the description of the types, however, there can be little passing on of the responsibility to someone else. This must rest with the state workers and whatever federal men may assist in the field

Whatever gives promise of reducing the errors in mapping or of improving the type descriptions by making them more accurate, more comprehensive, and of more agricultural significance merits a trial.

In dealing with the survey of any county it is the general practice, we believe, to first complete the field work, mapping the soil types and making more or less complete notes, leaving the writing of the description of the soil types that have been mapped, which includes their definition as well as the agricultural development, productivity and crop adaptations of these, until the last. We submit that much might be gained by giving a part of this literary effort an earlier place on the programme of areas that are not contiguous to one or more counties already carefully surveyed. This would be the early formulation of exact definitions of the soil types as encountered, or as recognized in the course of the survey--putting them down in black and white--to be constantly revised, corrected, made more accurate and significant as the work progresses.

Uncertainty in mapping is often due to the want of sufficiently sharp definitions of the various types encountered or to an imperfect appreciation of these definitions by the field men. A really serious problem is presented by the occurrence side by side, or interpenetration, of types that have much in common, as for example several silt loams, more or less similar in origin, topography, natural vegetation and agricultural use. With these the placing of boundaries may at best be somewhat arbitrary and under ordinary circumstances it becomes largely a matter of chance to which of the types any particular field will be assigned. Two trained surveyors working independently of one another under present conditions may make very different mappings. Thus if the total acreage in one township of three such similar types, which we may refer to as 1, 2 and 3, amounts to 18,000 acres, Surveyor A might map 10,000 acres of type 1 and 2,000 acres of type 3, while Surveyor B might map only 5,000 acres of type 1, but 9,000 acres of type 3. It may be this way even when two men work together, sleep under the same roof and ride out in the same car in the morning. Many of you will probably be able to recall specific instances of this character. The larger the party that includes only one well trained and experienced man as leader the greater in general is the probability of this uncertain, and in the end misleading

mapping. This is due to the men not having in mind similar type definitions which we may regard as yardsticks or to not knowing just how to make use of these. A definition of each soil type in black and white serves as a yardstick and the constant testing and improving of it makes the field man an expert in its use.

By the exact definition of the soil types, the early formulation of which we suggest, we do not mean accurate and complete descriptions, but for each type a definition, stated in as precise language as the keenness of the surveyor's observations will warrant and his vocabulary will permit, in which will be included all the characteristics which he has observed. When he has thus put his ideas down on paper, he will in the following days recognize many serious errors in the details or in the generalizations, and may often discard the original and decide that what he regarded as several distinct types should all be mapped as one. This will also permit his co-workers in the area to have a definite statement of the leader's ideas for additions, corrections, and more exact statement--thus allowing of definitions that make use of the knowledge, powers of observation and individual experiences of the whole party. With the revised definitions--what might be called the "party definitions" in the possession of all, in their pockets, if not in their heads, they are provided with similar measuring sticks to continue the work. As all may thus have a wider and more exact acquaintance with the types that have been encountered in the parts of the area mapped by any of the party, their subsequent mapping should be more in accord. Further, the submission to a central office of these early definitions and their later revisions will permit of useful suggestions and kindly criticisms as well as an intelligent request for an acceptance of samples for laboratory examination.

How "early" in the survey of any area should the first formulation of definitions be attempted? That must depend upon the mental habits of the field men and upon their experience. We suggest that the first attempt be made not later than the evening or the morning following the second day in the field. An evident requirement for this is the furnishing to each field man of a loose-leaf note-book of convenient pocket size, with a liberal supply of form sheets printed for the purpose, so as to economize in writing, and plenty of blank pages for insertion where elaborate notations are required. From time to time, as at the end of each week, the definitions could be revised--so that all the workers could continue to use similar yardsticks.

The practice of early written definition of types would involve more mental effort on the part of the field men early in the work in each area, but there would be far less painful effort at the close of the work in trying to write accurate descriptions of profile, crop adaptations, etc. from memory and from scattered notes,--long grown cold. Not only does the practice promise to give more reliable and less arbitrary mapping and fuller and more accurate descriptions in the newer districts, but also, by so strongly encouraging the field men to check their own observations and to be more constantly on the alert, would tend to place responsibility and more rapidly differentiate the more promising young men.

Some may say that the system of early descriptions is not feasible, but to this we may reply that we have tried it during the past season. Others may say that it is already in use. If so, let the rest of us have as full information as possible as to your experience, as we had been unable to learn of such a practice in any state.

A NEW SPEEDOMETER FOR SOIL SURVEY WORK

By T. M. Bushnell, Indiana Soil Survey, Prepared in part from information supplied
By L.A.Wolfanger, U.S.Bureau of Soils.

At the request of Mr. L. A. Wolfanger of the United States Bureau of Soils, the Stewart-Warner Speedometer Corporation designed and made Model 131-A especially to meet the needs of Soil Survey work with Ford cars.

This model resembles ordinary speedometer heads in outside appearance but differs in the odometer element which resembles the diagram below.

The "season" mileage side can not be set back; registers up to 1000 miles and repeats; shows tenths and hundredths of a mile by the two red figures, thus giving direct readings in "spaces" when mapping is on the scale of 2 inches equals 1 mile.

For tire mileage records, etc. it is necessary to make note of each 1000 miles traveled.

The "trip" mileage side is especially adapted to mapping on the scale of 1 inch equals one mile and to using the alidade with 50 divisions or "spaces" per inch. The readings are given direct in spaces. That is, the illustrations can be read 75.8 spaces. This side of the speedometer registers to 100 fiftieths of a mile, equivalent to 100 spaces or 2 inches on the map, then repeats. It may be set back to zero at any time by means of the trip setter.

All figures of the odometer turn up quickly at their proper time, except 1/500 wheel, which moves continuously in direct proportion to the movement of the car, and since it is possible to estimate 1/10ths each figure on this scale the instrument will give readings to 1/5000 of one mile or about one foot.

With constant tire pressure this device will give consistent results. In tests on the road the readings between two points a mile apart checked within 3 to 8 feet without being affected by the speed of the car, and one 30 mile trip checked within 50 feet for the total distance each way.

In order to obtain absolutely correct readings it may be necessary to prepare a conversion table, but in practice the following plan will do. An exact measured (chained) mile should be marked on a straight, hard, smooth road near headquarters of the Soil Survey area. The car should be fitted with a make of casing which will give a reading of 50 spaces or less when inflated to maximum pressure (60 lbs.) and driven over the measured mile. If the reading is less than 50 spaces this may be corrected to make it read 50 by reducing the air pressure. A reduction of air pressure from 60 pounds to 50 pounds will increase the speedometer reading about .26 space per mile, and reduction from 60 pounds to 40 pounds increases the readings about .49 space per mile.

Tests on the road indicate that turning out for other vehicles, etc., does not materially affect the readings, as turning across a wide road 30 times in one mile increased the measurement only 1/2 space.

Many of the advantages of this speedometer for Soil Survey work with a car are obvious. Among them are (1) great accuracy, (2) easy to read as figures are

large, (3) self contained, compact, almost fool proof and trouble proof, (4) easy to set at zero, (5) readings direct in spaces, (6) the trip side can be disengaged and be free from wear when not actually in use.

The rapid movement of the extreme right hand figure may seem confusing to the eye while the car is in motion, but it is easy to become accustomed to that feature, and of course, when very accurate readings are desired the car is naturally stopped.*

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* A model of the above described speedometer was supplied by Mr. Wolfanger and was on display at the meeting of the Association. It aroused a great deal of interest. We understand that speedometers of this type can now be secured from the Stewart-Warner people for $20.00. It is felt that this will be a great help and convenience to all who are doing traverse work in a country where an automobile can be used. We would be pleased to have reports from any who may use this speedometer during the coming year.

The Secretary.

THE EFFECT OF TIRE INFLATION ON READING OF STEWART SPEEDOMETER.

In using the Stewart Speedometer on a Ford car for traverse work, it has been the common belief among many that the tires should be kept inflated at 55 or 60 pounds pressure, in order to give correct readings. To determine the amount of variation in readings that would be obtained with the tire at different pressures, a short trial was carried on.

A definite distance was chosen for a traverse on a straight, hard surface, gravelled road, in order to eliminate errors in excessive jumping or slipping of wheels caused by ruts, bumps, and soft dirt. The tire was then inflated to 60 pounds pressure, the traverse made and readings taken at the various stations. The pressure was then reduced to 40 pounds and readings taken again at the same stations. This trial was repeated again to check up the readings.

Comparing the total difference in the readings between stations No. 1 and No. 6 with the tire inflated at 60 pounds and 40 pounds pressure, a difference of only .02 miles in approximately five miles was found.

As will be seen from the table, a difference of 20 pounds pressure makes but a very slight variation in reading and for short distances, may be considered negligible, since the personal error in reading distances of one mile may amount to .01 mile.

J. A. Machlis
W. H. Pierre

South Dakota State Soil Survey.

TESTS WITH STEWART SPEEDOMETER.

Station	40 lbs. Pressure				60 lbs. Pressure			
	Test No.1.		Test No.2		Test No.1.		Test No.2.	
No.	Reading	Distance between stations	Reading	Distance between stations	Reading	Distance between stations	Reading	Distance between stations
1.	64.16		63.96		73.94		54.16	
2.	65.34	1.18	62.78	1.18	72.76	1.18	55.33	1.17
3.	66.32	.98	61.79	.99	71.78	.98	56.31	.98
4.	67.29	.97	60.83	.96	70.82	.96	57.27	.96
5.	68.28	.99	59.84	.99	69.84	.98	58.25	.98
6.	69.03	.75	59.10	.74	69.10	.74	59.00	.75
Total Difference		4.87		4.86		4.87		4.84

SECRETARY'S REPORT

AMERICAN ASSOCIATION OF SOIL SURVEY WORKERS COVERING THE YEAR 1920-21.

Nov. 19-21.

The activities of the Association for the past year have been directed chiefly to follow up the instructions which were given out by the Association at the annual meeting in Chicago, November 1920. In January 1921 bulletin No.1 of the Association was issued giving a complete report of the first annual meeting. Copies were issued and distributed to soil workers throughout the country.

The committees on Utilization and Legislation supplied material for a statement on the usage of the soil survey. This was published as bulletin No. 2 of the Association and a first edition of 5000 copies was printed. The second edition of 3000 was printed later. These bulletins were first distributed in March 1921 and up to the present time approximately 6000 copies have been sent out, leaving on hand about 2000 copies. These bulletins were sent in bulk to 36 different soil workers, and complimentary copies went to numerous others in this and foreign countries. About 2150 copies were sold.

MEMBERSHIP.

At the time of the annual meeting in 1920 there were 55 members in the Association. At the present time there are 136 members. These members are distributed among 34 states, 8 Canadian Provinces and the Philipine Islands.

THE AMERICAN ASSOCIATION OF
SOIL SURVEY WORKERS.

(Signed) W.J.GEIB,

Secretary-Treasurer.

TREASURER'S REPORT

AMERICAN ASSOCIATION OF SOIL SURVEY WORKERS COVERING THE YEAR 1920-21.

Nov. 19-21.

RECEIPTS:

Amount on hand November 20, 1920	$ 157.80	
Receipts for membership dues	123.00	
Received from the sale of 2150 copies of bulletin No. 2	57.00	
Total		$ 337.80

EXPENDITURES:

November 23, 1920 services of janitor at Chicago	$ 2.00	
January 7, 1921 drafting work Miss Pitman	5.00	
January 8 zinc etchings	9.84	
January 17 cutting stencils	5.00	
January 17, stamps	10.00	
February 26, railroad fare	1.90	
February 28, stamps	2.00	
March 29, Drafting	.89	
April 5, 5000 copies of bulletin No. 2	125.00	
March 21, stamps	10.00	
July 25, halftones for bulletin No. 2	33.52	
August 9, express charges	2.63	
August 9, printing 3000 copies bulletin No. 2	75.00	
September 10, stamps	6.00	
		$ 288.78

Receipts for 1920	$337.80
Expenditures for 1921	288.78
Balance on Hand for 1921	$49.02
Dues collected for 1922	$ 68.00

Total amount in treasury at the present time $117.02

THE AMERICAN ASSOCIATION OF
SOIL SURVEY WORKERS.

(Signed) W. J. Geib,

Secretary-Treasurer.

MINUTES OF THE BUSINESS MEETING OF THE AMERICAN ASSOCIATION OF SOIL SURVEY WORKERS
HELD AT EAST LANSING, MICHIGAN, NOV. 19, 1921.

1. Meeting called to order by President Miller.

2. Minutes of previous meeting held Nov. 19, 1920 read and approved.

3. Report of Secretary-Treasurer read and accepted.

4. A Steering Committee consisting of G.W. Conrey, A.R.Whitson and C.Marbut were appointed to work out plans for the general policy of the Association, committee assignments, and nomination of officers.

5. On motion of Prof. Shaw the Association went on record requesting the Bureau of Soils to prepare for publication as a Bulletin of the Department that part of the monograph on the principles of soil development, which is now being prepared by Dr.Marbut at the instigation of the National Research Council, in so far as it applies to the conditions east of the Rocky Mountains.

6. Dr.Alway made a motion that the name of the Association should be changed to the North American Association of Soil Survey Workers and the membership enlarged to include all soil workers. This motion was amended to refer these questions and also the questions of becoming associated with the Society of Agronomy to a committee which would report at the next annual meeting.

7. Upon motion of Prof. McCool provision was made for a committee on the classification of organic soils.

8. Report on Steering Committee:
   (a) Assignment to committee as given below.
   (b) It was recommended by the committee that the Association remain as a separate organization for the present time or at least remain as a separate division for the time being, as this would give soil survey work better recognition and help to insure greater interest in this line of work.
   (c) The committee also recommended that the next annual meeting of the Association should be held at the University of Illinois.
   (d) The Committee recommended that a committee consisting of W.J. Geib, H.H. Krusekopf and J.O. Veatch be provided for the purpose of making further studies in the improvements of soil maps and reports, and that the Bureau of Soils authorize the Chairman of this Committee to spend several weeks during the winter of 1921-22 in some well known lithographic plant for the purpose of becoming better acquainted with lithographic work and with the possibilities of making such changes in soil maps as may from time to time seem desirable.
   (e) The officers nominated for the coming year: President, A.T. Wiancko, Vice-President, F.J. Alway, Secretary-Treasurer, W. J. Geib.

9. On motion made the secretary was instructed to cast the unanimous vote of the Association for all the officers and committee assignments presented by the committee.

10. Motion was made to the effect that a question of the time and place of the holding of the next annual meeting should be left in the hands of the executive committee with the recommendations that the place of meeting be at the University of Illinois and that it should be held at such time as would make it possible for the largest number of field men to attend.

11. The American Association of Soil Survey Workers favors having the United States Bureau of Soils make complete chemical analyses of representative samples of soil from the several states. The object being to aid the states which are not now prepared to do this work, and to make possible in all states a more comprehensive study of the soils within and adjoining each state. It is believed that such chemical work would aid in the correlation of soil types, and make it possible for the soil workers in each state to become more familiar with the soils and soil problems throughout the entire country.

AMERICAN ASSOCIATION OF SOIL SURVEY WORKERS.

12. Officers and Committee Assignments for 1922:

OFFICERS:
Pres. - A. T. Wiancko
V.Pres. - F. J. Alway
Sec-Treas. - W. J. Geib

COMMITTEES:

Color Standards:
J. G. Hutton
T. D. Rice
A. M. O'Neal, Jr.

Information and Publicity:
P. E. Brown
C. F. Shaw
W. E. Hearn

Legislation:
A. R. Whitson
G. E. Condra
F. J. Alway

Improvement in Soil Maps and Soil Reports:
W. J. Geib
H. H. Krusekopf
J. O. Veatch

Correlative Laboratory Work:
G. W. Conrey
M. M. McCool
R. S. Smith

The following special Committees were appointed by the incoming President:

Committee to consider change of name and field of Association, and question of joining with Agronomy Society:
M. F. Miller
F. J. Alway
Robt. Harcourt
C. F. Marbut
P. E. Brown

Committee on Classification of Organic Soils:
F. J. Alway
A. R. Whitson
M. M. McCool
S. D. Conner
R. S. Smith-Ill.
C. F. Shaw
H. H. Bennett

REFLECTIONS ON SOIL-SURVEY WORK

by

M. W. Senstius

Department of Geography, University of Chicago.

I know full well that one should not begin his talk with an opology. Yet in this case I feel you are entitled to one, for sooner or later you will find out that, so far, I have had only one summer of field-work, viz. last summer. But it is just this short practical experience - coupled with many years of theoretical studies on soil-surveys and soil-survey methods - it is mainly my short practical experience which prompted me to offer you the following remarks. You will soon notice that my remarks pertain mostly to such things as afford great difficulties to the beginning field-man if he is conscientious and has a critical mind. No doubt, most of the "old-timers" among you - if I may use that word - must have experienced similar difficulties in the early stages of your career. But more experience has taught you to adjust yourself, sacrificing in many cases demands that seemingly could not be fulfilled, until finally you may have become no longer aware of having made sacrifices against your better judgment. My object is to recall to your mind some of those initial difficulties and to discuss how we could do away with them.

One more thing as an introduction. I hope ever so much you will not take my remarks as born of an inherent and vicious desire to criticise everything good or bad. Let me assure you that the methods of the Bureau of Soils I became practically acquainted with last summer I consider by far superior to any other system so far known to me. Yet, your being present here to discuss improvements of that system, those methods, I take it, indicates that you do not consider them as final. Perhaps you are willing to discuss suggestions even from one who has had so little practical experience as myself.

1. The first topic I would like to suggest for discussion is the desirability of having a large scale base-map for the detailed survey.

The present scale of approximately one inch to the mile is claimed to enable one to map differences in soils within an area of 10 acres. Last summer I had the privilege to work under men with considerable and varied experience but in no case could their work convince me of the validity of the claim as mentioned above. Even if we grant the fact that experienced field-workers can perform the feat, still there are the very many new and inexperienced men which every year fill the ranks and have to do largely independent work only too soon. I am loath to think of the many mistakes and inaccuracies I must have committed, although I have no reason to believe that I was less prepared for the work than most of the newcomers.

Again, more and more we should begin to realize that it is of paramount interest exactly to know the places where representative soil-samples have been taken. It no longer seems sufficient simply to indicate townships and ranges, nor even does it seem enough to indicate by quarter-sections or by a dot or across on the base-map of 1" to the mile, which may actually mean an area of 1 to 10 acres.

For these and similar reasons it seems to me that the present scale of 1:62,500 in the case of detail-maps is inadequate and should be at least increased to 1;25,000 (± 1" = 2100 ft) or still better 1:12,500 (± 1" = 1000 ft).

If it be impracticable to publish such a large scale map to accompany the reports, I may suggest that, at least, the base-map or the field-map be made on that scale and be permanently kept for reference in one or two copies at a central office. Base-maps of this scale can now easily be made by photographic enlargement of topographic maps and be given out to the field-man. In case there is no topographic map available for enlargement and the map has to be made in the field, surely the greater accuracy and detail would fully justify the but slight increase of time and money spent in the field.

II. The second point I would like to raise for discussion is the question of how best to take soil samples.

The most common way in use in this country is that by means of the soil-auger of 1 1/2" or smaller diameter. Never did I see even the most experienced man bring up a clean sample of the desired depth. In view of the fact that the sample is necessarily small the amount of not-desired material from another horizon should by no means be neglected. The soil-auger, consequently, has long since been found unsatisfactory in foreign countries as a soil-sampling tool, i.e., as an implement with which to collect soil-samples for analysis in the laboratory. I do not know of any of the foreign countries which still uses it for that purpose.

A modification of the soil-auger is the post-hole auger or digger of some 4" diameter which I saw used last summer also. Owing to the greater diameter of the soil-core the admixture with foreign material, i.e. material not belonging to the desired horizon, is of lesser importance than in the case of the ordinary soil-auger. But, aside from the fact that a 4" post-hole auger is quite a clumsy implement to carry in the field, both the auger and the digger have one serious defect in common which defect, in the opinion of many soil-workers, condemns them as soil-sampling tools. I am referring this time to the fact that it is impossible, with either of them, to get a true sample of a specified depth nor a true representative sequence of soil-horizons, I mean a true soil-profile. The importance of the soil-profile, i.e. the sequence of layers and their respective thicknesses is slowly but surely being recognized. The best method to study these in the field and to take truely representative samples seems to be to dig a hole of sufficient size to enable the soil-worker to stand up in the hole and make such observations and measurements and do such sampling as he finds necessary. This is the official method as adopted f.i. in the Netherlands East Indies.

Another method perhaps equally effective and saving more time and labor is one apparently practiced a great deal in Russia. Glinka has described and depicted it on pp. 11-13 of his book "Typen der Bodenbildung" (Berlin 1914).

If both methods be found impracticable, the soil-surveyor should at least be provided with a handy digging tool, besides his auger, rather than with a hammer. Perhaps the trench-diggers which the soldiers used in the late war would suit the purpose: I have never seen them. But here is an instument that I am showing you simply to demonstrate both the combination of shovel and spade and the convertible principle. If made sufficiently strong and modified a little

bit, I believe, it would be a more valuable tool than the hammer and no more cumbersome to carry in the field.

III. A short while ago I mentioned the importance of the soil-profile for modern soil-studies. I had occasion to find out that the soil-profile is one of the things that most interests the .... well, in my case it was the planter in the tropics, but I am inclined to believe the same will hold true with regard to the farmer in our regions. In November 1916, exactly five years ago, we had our first soil-congress and exhibition in the Netherlands East Indies on the island of Java in the city of Jogjacarta. The experiment station I was then connected with was requested to send in whatever material it deemed worth while. Owing to the youthful age of our station and the lack of equipment as a result of the war we had only been able, at that time, to collect material for future researches. Results of soil-investigations we had none to show. Finally the idea was conceived to exhibit the different soils of our area in their natural profile. The success was greater than we expected: the exhibit immediately attracted the interest of practical planters who keenly appreciated the characteristics and different behavior of their soils.

There seems to be no doubt as to the educational value of just such a collection for farmers, students and county agents. But for the soil-surveyor also such a collection would be of immense value. It would enable him in cases of doubt to compare his material with the "type specimens", as the geologist would say. Furthermore it would enable the beginner, or the stranger in a certain region, to quickly acquaint himself with the soils likely to be met with, other than by reading descriptions which, as most of us must have realized, are often distressingly inadequate.

In order that such a collection of representative soil-types be effective each profile must be on a sufficiently large scale. I used tin-plate boxes, 10 cm. square and 75 cm. high, provided with a glass plate on one of the long sides. These containers I filled with soil as collected up to a depth of 1.50 m. Each different layer of soil consequently was represented by a column one-half its actual thickness and was separated from the next by a partition of card-board. A legend pasted on top bore a short description of each layer. The diameter of the box permitted fairly-large boulders to be included, if such were encountered in any one of the layers, and the whole was really quite representative of the natural profile. Modifications will readily suggest themselves, such as displaying, at the same time, the results of the mechanical analysis, etc.

Such a collection of representative soil-types in their natural profiles, I imagine, would best be kept for display and reference at the State Agricultural Colleges.

IV a.V. Finally I would like to bring up for discussion two minor points, both of which are, perhaps, more or less of academic interest, viz.

(a) the desirability of more complete meteorological and climatological data to be incorporated in the soil reports;

(b) the desirability of the mineralogical analysis of soils, the results of which to be similarly published in the soil-reports.

bit, I believe, is [illegible] valuable [illegible] than the [illegible] [illegible] in the field.

(11). A short time ago I mentioned the importance of the soil-survey for experimental-stations. I must mention [illegible] is one of the things that [illegible] it was the planter in the tropics [illegible] [illegible] [illegible] [illegible] India [illegible] The experiment station I [illegible] whatever material it [illegible] to the possibility of the station and the lack of equipment as a result of the war [illegible] able, at that time, to collect material [illegible] Results of soil-investigation [illegible] exhibit the different soils of one area in small natural profiles. The success was greater than we expected; [illegible] interest of practical planters who keenly appreciated the characteristics and different behavior of their soils.

There seems to be no doubt as to the enormous value of such a collection for farmers, planters and county agents. [illegible] such a collection would be of enormous value. It would remove the cause of doubt [illegible] "type descriptions" [illegible] at a certain region, [illegible] quickly acquaint himself with the soils likely to be met with, [illegible] by reading descriptions which, as many of us must have realised, are often disastrously inadequate.

In order that such a collection of representative soil-types be effective each profile must be on a satisfactorily large scale. I used iron-plate boxes, 10 cm. square and 75 cm. high, provided with a glass plate on one of the four sides. These containers I filled [illegible] up to a depth of 1.00 m. Each different layer of soil consequently was represented by a column one-half its actual thickness and was separated from the next by a partition of cardboard. A label pasted on the glass gives a description of each layer. The diameter of the [illegible] to be included, [illegible] one of the layers, [illegible] was really quite representative of the natural profile. [illegible] will readily suggest themselves, such as displaying, at the same time, the results of the mechanical analysis, etc.

Such a collection of representative soil-types in their natural profiles & columns, would best be kept for display and reference at the State Agricultural College.

(12). Finally I would like to bring up for discussion the minor points, [illegible] of which are, perhaps, more or less of academic interest, viz.

(1) the [illegible] lists of [illegible] complete [illegible] and climatological data be an incorporation in the soil reports,

(2) the desirability of the mineralogical analysis of soils, the results of which be similarly published in the soil-reports.

More and more I am inclined to believe that climate is the principal factor in soil-formation i.e. in the making of differences in soils. I do not purpose to say that climate is the only factor, but the most potent one. Now, to many of you this statement, when applied to major soil-regions, may be commonplace. You will no doubt recall such soils as laterites, chernosem, terra rossa, etc. which have long since been considered as characteristic of certain climatic regions. But even in small and the smallest area I believe intensive research will show the dominant influence of differences in meteorological and climatic conditions. Such intensive studies of small areas are sadly lacking; I know only of one which has converted me to the belief as stated above. It is a small book by a botanist entitled: Kraus, "Boden und Klima auf kleinstem Raum" (Jena 1911).

Most important among meteorological data to be collected is the ratio between precipitation and evaporation. That ratio determines the upward or downward movement of water and the weatherings products therein contained, thus lying at the bottom of such processes as enriching or depleting the soils of mineral material.

These meteorological data, however, are sadly lacking; the meteorological stations do not seem to make such observations as yet. It would be highly desirable if they could be induced to get started along that line.

Lastly there is left for discussion my special hobby, viz. the desirability of a systematic mineralogical analysis of soils the results of which are to be given in the soil-reports.

McCaughey & Fry at the end of their remarkable booklet on "The Microscopic Determination of Soil-forming Minerals" made this statement:

> "Work is now in progress with the distinct end in view to determine the extent of the mineral complexity of the more prominent American soil types, and it is expected that the results will be collected and published for the use of other investigators at an early date".

The "other investigators" are still waiting, nay longing for the promised publication; no doubt they all would wish the results to be made available soon.

Just how important it is to know what minerals are present in a soil and in what proportion, need hardly be emphasized in the light of the newer knowledge concerning the role of zeolites and zeolitic minerals in soils.

There are several more needy subjects to be investigated in this line; I may only remind you of the iron-phosphates, manganese and aluminum-compounds, of which we know yet next to nothing. -

It is erroneous to believe there is such a thing as "science for science's sake". All scientific contributions sooner or later will find practical application, in many cases even very soon in these days of rapid human progress. In view of these facts it would seem unwise to defer the study of problems which at first sight appear to have only an academic interest.

In conclusion, it seems to me that we put altogether too much emphasis on the present generation of farmers whereas we should at least pay as much attention to the rising generation which will be of quite a different type. This forecast can be made on the base of the large number and steadily increasing number of students in the agricultural colleges. They can not all become teachers or soil-surveyors. In due time we will be able to reach them with scientific language. If eventually why not begin now.

With compliments of the Association.

BULLETIN IV VOLUME I

REPORT OF THE THIRD ANNUAL MEETING
OF
THE AMERICAN ASSOCIATION OF SOIL SURVEY WORKERS

HELD IN

UNION BUILDING, UNIVERSITY OF ILLINOIS

URBANA, ILLINOIS

NOVEMBER 17 & 18, 1922

Report Issued From The Office Of The Secretary,
Department Of Farm Crops & Soils, Iowa State College,
Ames, Iowa

March 1923

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ACKNOWLEDGMENTS

The association is greatly indebted to Dean Mumford and the officers and members of the Agronomy Dept. of the University of Ill. through whose efforts we were given the use of an auditorium in Union Hall, University of Ill. in which to hold our third Annual Meeting.

The members of the Association who were in attendance wish to particularly thank the officers and members of the Agronomy Dept. of the University of Ill. for the splended banquet tended them at the Inman Hotel.

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The Association wishes particularly to thank the U. S. Bureau of Soils for their very splended cooperation and especially for the work of cutting all the stencils for this Bulletin. It further desires to extend to the Dept. of Farm Crops and Soils of the Iowa State College their hearty appreciation of the interest they have shown in promoting the affairs of the Organization.

The third annual meeting of the American Association of Soil Survey Workers was called to order by Pres. Wiancko. Dean Mumford of the University of Ill. opened the Conference with an address of welcome. A report of the conference follows.

A. M. O'Neal, Secretary.

ADDRESS OF WELCOME

Dean H. W. Mumford, College of Agriculture, University of Illinois.

I do not need to tell you men in this field that there is a very general recognition of the fundamental importance of soil survey work. You are fortunate in being in that field. I say that because one of the greatest difficulties and one of the greatest handicaps that we have to agricultural progress in this country or in any country is the recognition of the fundamental things in the agricultural field. One of the most difficult things in agricultural research is to determine what are the fundamental things, the things that are most needed to make a more stable and a more profitable and a more satisfying farm life, and having determined what those fundamental things are, to secure for those things the necessary and proper support. So I say that you have gone quite a long ways by securing recognition for what seems perfectly evident one of the most fundamental things in the field of agricultural research.

You are fortunate from another angle, and that is that you are in a field of work where your constituency does not demand or expect immediate results, which is another great handicap to agricultural progress. It is much easier, as we all know, to get adequate support for things that promise immediate results or results which people think are going to be immediate, than it is for the fundamental things. I think that Illinois was exceedingly fortunate in having a man like Dr. Hopkins who was able in the earlier history of this institution, and I speak of the early history of the Agricultural College because that was something like only twenty years ago. It was in the earlier history of our Agricultural College and Experiment Station here that we had a man like Dr. Hopkins who was able to go before the people of the state and the State Legislature and show them the fundamental importance of this sort of work and get adequate support for it. In fact, so well did he do his work that it was difficult to get money for other agricultural purposes, but we all recognized, not only the people in the College of Agriculture, but in the whole University as well, that it was not good policy to try to put the brakes on Dr. Hopkins and the soil survey work in order to get something else. We felt that it was a good thing to get that, even if we couldn't get anything else.

This brings me to my last and final point which I want to bring to your attention, and that is the wisdom and desirability of being loyal to your agricultural institution and your agricultural people. Sometimes the agricultural workers, investigators, and teachers in some institutions are very busy in criticizing the work of investigators and teachers in other institutions. Now, men, we are in the business of trying to do something for agriculture, all of us, and we are all too busy to mind other people's business. One of the greatest needs of agriculture today, and I do not confine this to the faculties and staffs of the Experiment Stations, but to farmers throughout the country, one of the greatest needs in agriculture today is to build up a pride in their agricultural institutions and to build up a loyalty for their agricultural institutions, and we as their chosen leaders, must not forget that when we try to tear down the confidence that people have in other agricultural investigators or teachers, we are destroying the very thing that we have got to build on in bringing about agricultural progress in this country. So I beg of you to try to be charitable with each other and confine yourselves to your own job and you will have a man-sized job.

SOULD WE HAVE STATE LEADERS OF SOIL SURVEY WORK.

By M. F. Miller, University of Missouri.

At each of the previous meetings of this association informal mention has been made of a plan for providing in each state what might be termed a state leader or state inspector of soil survey work. As nothing very definite has come from these suggestions, I have considered it worth while to bring this matter before the association in a formal manner, for the purpose of encouraging some definite action along this line.

Following the first suggestion of this matter, the plan was adopted in Missouri and we have found it very satisfactory. The only difficulty we have encountered has been that of financing the project, although thus far we have been able to do this. Wisconsin has had some such plan in operation for several years, and I think there are other states moving in this direction. To me the plan seems a wise one and I should like very much to see this association take some definite steps to bring about its general adoption.

In suggesting such a plan I do not, of course, mean to minimize the importance of the work of the federal inspectors. Federal inspection is absolutely essential in order that a unified system of classification and correlation may be carried on throughout the United States. However, the detail of mapping has increased enormously during recent years. I think the first soil survey map which I helped to make, about twenty years ago, recognized but six soil types. I have no doubt that if this county were remapped today, not less than twenty types would be distinguished. Some of the earliest Missouri maps recognized but four soil types, while in most of our recent counties the number of types identified runs from twenty to thirty-five. Obviously the difficulties of the federal inspector have greatly increased. Likewise the knowledge of our field men must be much greater than formerly. It is perfectly obvious that if maps are to be made accurately, with this great amount of detail, much closer inspection must be given the field men than formerly, and it seems to me that we must look to state, rather than to federal agencies, for this increased amount of supervision.

A second reason for the adoption of this plan, is that of recognizing the local peculiarities which obtain in the various states. Such peculiarities may readily be recognized by a man who is continually working within the state, while they may be overlooked entirely by the federal inspector who makes only occasional visits to the areas. In practically every county, cases arise where the point of view of the federal inspector is quite different from that of the local man. This difference of opinion usually arises from the greater familiarity of the state man with the local peculiarities. I think it is essential for the most consistent soil mapping, that the point of view of the state man shall be given due weight in the classification. Without a state leader this is usually impossible and the decision of the federal inspector is final. I believe the decisions regarding classification and correlation should, in all cases, be joint decisions. There may, of course, be cases where it will be practically impossible to reach an agreement, but such cases will be rare.

A third reason for the adoption of this plan, is that the preparation of the soil survey report should not be left entirely to the field men. Where the soil survey party leader is a federal man, we have, at times, had difficulty in

getting our point of view before him. In fact, I find that the federal men are not always open to suggestions as to what should or should not be included in a report. Certainly the reports could be greatly improved if they were the result of a free exchange of ideas by the federal and state men. Where the plan under consideration can be adopted, I think it should be the duty of this state leader to assist in the preparation of all county reports, and a definite understanding to this effect should be had with the federal authorities.

As to the type of man to be chosen as the state leader, there will, of course, be differences of opinion. In some states the man in charge of the soils work at the college, may function in this capacity, although I am inclined to think that in most cases he will not find it possible to keep in sufficiently close touch with the field work to maintain absolutely reliable judgment in the matter of soil classification and correlation. Certainly he will wish to be consulted on all matters of first importance, but he can scarcely be expected to visit the field parties with sufficient frequency to be of the greatest assistance in the matter of detailed classification. I believe that in most cases this leader should be one who gives his entire time to soil survey work within the state and who is thoroughly familiar with the soils, as well as the agriculture. It should be his duty to visit the various field parties frequently, and to give constant assistance in the matter of classification and correlation. In states where only two or three field parties are maintained, this man will doubtless head one of these himself. It would be advantageous, in this case, to arrange that his field assistant be an experienced man, in order to allow full freedom in visiting the other parties. Where a large number of parties is maintained, practically the entire time of this man during the field season should be utilized in supervision.

The relation of such a state leader to the federal inspector should be one of cooperation. He should always accompany the federal inspector on his inspection trips and together they should agree on correlations. It should be the duty of the federal inspector to see that the classification is in harmony with that of other states. It should be the duty of the state leader to see that the classification is consistent throughout his individual state.

One of the obstacles of the general adoption of such a plan as has been outlined, is that of financing it. Where the state appropriation for soil survey work is small, such a plan may not be considered feasible. Even in this case, however, it seems to me that the most experienced state man should be selected to act as a state leader, while at the same time he is leading one of the detailed parties. In some cases it might be possible for the federal bureau to take care of part of this man's salary, although as a general policy, I doubt if this is wise. It will undoubtedly be better for this man to be wholly responsible to the state, rather than to have a divided responsibility.

I should like to see this plan discussed. It would seem that its general adoption would greatly increase the accuracy of soil mapping. I believe it is a logical development of the present plan of federal and state cooperation.

Discussion.

Discussion of Address - "Should We Have A State Leader of Soil
Survey Work?" - M. F. Miller, Missouri.

Dr. Marbut

"This matter is a very important one and is a very desirable one from both the state point of view and the Bureau point of view. There are two distinct points of view that are combined with all sorts of work, the scientific and the practical points of view. The scientific point of view is the one that the Bureau must necessarily take. That does not exclude the practical point of view, but it is utterly impossible for the Bureau of Soils man to come as near to the farmer and be as practical as the state man, and too, the special problem of the state man is to get close to the farmer and interpret to him the results of the work.

"In order that some one man be in charge of the work and be able to interpret that properly to the people of the state, it is certainly a very desirable thing for the state to have a leader. It is probably impossible for the government to pay even a part of the salary of that man, and I doubt if it is desirable that that should be the case. I doubt it is desirable that a government should in any way have control of a state leader. The government must take care of its own side of the matter and the state should take care of its side. There are certain important considerations that are necessarily nation-wide, and there are other considerations that are necessarily state-wide, or at least within the state, and it should be the special province of the state man to dictate on matters that concern the state solely. It should not, however, be the province of the state man that any correlation within the state should violate a general principle that should obtain in nation-wide matters.

"There is one thing more, the question of maintaining the definition and name of a soil type after it has once been defined for an indefinite time. The Bureau has found it necessary in many cases to change soil names, to re-define soils. The paleontologists have changed the limits of the group Brachiopods many times. Soil definitions and soil identifications are going through exactly the same process. A state man should in no case interfere with a necessary readjustment such as that. I do not believe any state man has ever really interfered. We have had compromises, but compromises are the rule in this world."

Dr. Condra -

"We have experienced all of those things. I am going to be frank with you. We are working a scheme. We have been trying to utilize the Bureau men and let the government pay the bill and we have been doing it successfully. Just now I happen to be the Director of the soil survey work in Nebraska, with Mr. Hayes for the correlation work. We have had difficulties with Dr. Marbut, but we are getting great results, not only fundamental but basic. The trouble is this - a man comes in, tries the best he can to generalize on the soils of the state, but perhaps he has not been working long enough in the state to get acquainted with the soils. In Nebraska we have determined some things that we have not yet completed.

"I would like that this state leader might be a man to be in the state, not necessarily to correlate work, but to go out and get acquainted with the state so that he may be prepared when he goes into a county to outline the situation that maintains there. If he is unacquainted there and perhaps the federal inspector is - Mr. Rice worked on a reconnoissance survey and a great deal of this we are having to revise. It served the purpose to the Bureau,

but not to the farmer. The inspector comes down and goes over this and fights it out and then it comes to the publication of that report. In the publication of our own county reports, we are separating the state into 20 districts just as we think it should be separated.

"I disagree with Dr. Marbut on the scientific and practical points of view. I believe that we have what is really fundamental propaganda. If we would maintain that the state men deal with the practical side only, this is not probable, this must be technical. We must follow scientific methods, determine these things in the soil survey and then thru the soil reports let us supply the truth that is of use to the farmer."

Dr. P. E. Brown -

"The idea of having a state leader or someone who works for the state in its correlation - the suggestion is a good one. How it probably might be worked out is somewhat of a question in my mind. It has been said that in the correlation of soils, it is much more important that they be correlated by districts through the Bureau inspector than their correlation in the state. From that standpoint I do not agree exactly with Dr. Marbut's statement. The fundamental question is making it correlate within the state. After all, the correlation within the state is not very different from the correlation within the area. The main advantage in having a state leader or someone who would have more time to visit the different parties, would be that he could spend more time in each county and give the individual men more help in their correlation and mapping work. That would be a distinct advantage.

"However, we must not lose sight of the fact that we will have practical difficulties. With due respect to the administrative officers, we have got to convince them that these men are earning their salaries, and the idea of having too many men who are not definitely located does not appeal very often to administrative officers. In other words, before we can go to the extent of having a state leader, we have got to prove the necessity to the administrative officers. If we tell them that the state leader's chief duty is to go around the state to the different parties, immediately we can see what the comeback will be: "The Bureau of Soils maintains an inspector and we should draw upon them for this work." Bring the point to such an issue by a combination of various activities with this correlation work or a combination of some other activity with it, various activities would be most desirable.

"I might make this suggestion: The Bureau of Soils maintains what they call a correlation committee. I am wondering why in the correlation of the soils of a particular state, a certain man, who might be the state leader or in charge, might not meet with the Correlation Committee to make up the correlation of the soils of that particular state. I do not know whether this would be a practical thing to work out or not, but it would save a whole lot of their difficulties and an abundance of correspondence.

"There is one other point in connection with the reports. I can't agree with Professor Marbut that the state man should modify to any extent - - - the Bureau of Soils report. We get out a county report which follows up the Bureau report. We depend on the state report to give the practical interpretation to the Bureau report. We get some practical suggestions from the Bureau report, but in general we depend upon our state report to give the practical application. The Bureau report should remain a technical report, a com-

plete description of the fundamental soils as they are found in the state, but the state authorities should take the responsibility of applying them to their local conditions.

"I want to correct one other impression, that the only thing that the state people are interested in is getting the application to the farmer, how much organic matter or nitrogen he must apply. We are interested in the fundamentals of soil science in connection with our soil survey work just as much as the Bureau of Soils. We are doing a lot of fundamental investigation in regard to soil science and we are beginning to base these investigations on the soil type. I hope that the development in our various institutions of fundamental research in soils lines will increase and that we will realize that we must be carrying along some of this work with our field work. We must all have sound fundamental research coming along with it and we are doing something to build up science as a whole."

Dr. Marbut -

"Iowa and Missouri have state leaders. I would like to ask if those states and any other state have carefully checked up the amount of work done by that state leader, actual productive work. One of the things that we have got to watch is not to get too much overhead expense. A state leader must in my opinion at the present time be productive, must produce something in addition to mere correlation with the work that someone else has done. Has the state leader proved just as productive as any other man?"

Professor Miller -

"I should say he is. We only run two or three parties; of course a man does not have all his time taken in the field and he can do some other work. I am of the opinion that we must have someone absolutely in charge of the soils work for that matter. Where you have large Departments of Agronomy and where the man in charge does not get into the field, it seems to me that there must be some sort of a leader in charge. I realize that we are mapping soils in a national way and I tried to bring out that the state leader should in no wise minimize the importance of the federal leadership. Young men need more careful supervision than the federal inspectors can give.

"In regard to the soil reports, I feel that Dr. Brown is looking at the matter from the standpoint of the state report. I feel that we should have something more to say about the preparation of those reports than we have had, not that the reports will be changed materially but they certainly should meet the state point of view so that it will not be purely abstract reading to the man from the states.

"In regard to satisfying the administrative officers, I feel that this man (the state leader) does turn out the reports carefully and represents in the College an active soil survey man, a man who knows more about the soils than any other man."

Dr. McCool -

"We have had a state leader all this season and all the last season. I can't say very much about him because he is here, but we have been telling him he is pretty good. We are highly satisfied with this arrangement and for sever-

al years yet at least we will find it to be very profitable, I am sure. This man has made it possible for us to report this afternoon on a certain topic that if it hadn't been for this we couldn't have done this. If we didn't think he was as productive as the other men, we wouldn't have him out there. We are satisfied with it and think it is absolutely essential. We have covered the state, portions of it, ahead of those detail men and I consider that work to be very desirable."

Dr. Condra -

"As we progress in our state, someone should promote that work, more especially to standardizing the work of the field. We sent men to the field this summer and they failed because they did not have sufficient acquaintance with the border counties and a whole lot had to be done over. Now if we had had this state man, we would have checked them up."

Professor Wiancko -

"We have found the necessity of someone to represent the work who was going to be there year after year and follow it up from one part of the state to another. We started out with a new set of men each year, at least practically so, and they were in the state this year and out next year. That is one very important thing in having a state leader. I am supposed to be in charge of the soil survey in Indiana and we have a man, Mr. Bushnall, who is associate in soil survey. He is actually in charge of the field parties and works just the same as one of the other men. He is in the field all the time. He starts out with one of the parties and he can go to another county whenever necessary. He sees that the parties are working in harmony. The federal inspector can't visit the area often enough so that we can do without a state leader who will keep things properly lined up.

OUTLINES AND SYSTEMS OF COLLECTING ADEQUATE FIELD NOTES.

By W. T. Carter, Jr. Texas.

The activities of soil survey field work fall naturally into two main divisions, both closely related and interwoven. One includes the activities involved in making the soil map which when completed, shows the location and approximate extent of each kind of soil, while the other consists of compiling a report which gives all the required information concerning each soil type and phase individually, with their relationships to agriculture in general, with such other information as has a bearing on the agricultural operations within a given area.

The work of making the soil map requires considerable attention to many details. Many of these details involve a considerable amount of physical effort, while the construction of the soil map, especially where a base map has to be made with a plane table outfit requires a knowledge and practice of many subjects. The soil surveyors work in the field is largely done through the practical application of a variety of scientific branches, all closely related, involving therefore some knowledge of engineering, geology, chemistry, botany, physics, practical farming, economics, more or less diplomacy, and last but far from least a good understanding of the mechanic arts necessary in guaranteeing himself so far as possible a means of uninterrupted transportation throughout the day with the noble tin steed so universally used in soil survey work. Altogether, therefore, the soil surveyor has a vast amount of work to do requiring a knowledge of many things and necessitating considerable physical as well as mental work. There are so many details to look after in preparing the map and so much physical labor involved--the later tending to retard mental work--that many of us are inclined to delay or put off to some more propitious time the gathering of our field data. Especially is this true as regards the specific study of the soil section in all its characteristics and relationships, as well as in collecting both direct and comparative data along the lines of crop production the crop adaptations of the various soil types and soil phases.

Therefore, on the completion of the work of mapping the soils in an area we often find ourselves without sufficient notes and likewise without sufficient information for writing up our reports in such a way as would present all information which should be secured. We often depend too much on superficial examinations of the soils and fail to note characteristics of importance in soil descriptions. This has been to some extent due to the pressure the field man feels he is under to cover much ground and get as much area completed as possible within a given time. Therefore we seem to have the tendency to forget that we are scientists studying soils and are inclined to devote our greatest efforts to map making. Soil surveying is not an exact science. It is, however, a science. It consists in the gathering of facts in the field from many sources, and these should be secured from every source possible even though in some cases we do not know as yet whether some of these would have such a bearing as would give positive results. It seems that no detail can be overlooked if we are to advance our knowledge of soils. Many facts can be added together in time that possibly will divulge information of great value.

In making a soil survey we construct a soil map which is a foundation on which the report is the superstructure that completes the edifice. Too often

we do not rear a structure of corresponding importance to the foundation.

In gathering data in the field we frequently fail to note things of importance, sometimes through fancied lack of time, sometimes through forgetfulness, and sometimes because we do not realize the significance of some more or less outstanding feature.

For the purpose of facilitating the collection of field notes in complete form that can be filed systematically and used intelligently at any time it seems that an outline note form can be made up that will aid the field man considerably. As an attempt along that line we have been using an outline in Texas work which has given some satisfaction and which I believe is a start for something that can be made very useful. Since this note book has been placed in use a number of valuable suggestions have been made by our inspector and field men which will be followed when our next note books are printed. I am sure that in time experience with the use of these outlines together with suggestions will enable us to develop a very useful notebook outline system. We had not used this book long before a number of improvements suggested themselves.

It is possible that the arrangement of the note forms should vary according to the region in which work is being carried on so far as some of the details are concerned. For instance notes on the soil types in the western plains region where ranching is an importand industry would be somewhat different from notes collected on soil types in the east. Also in a country where irrigation is practiced, or where alkali is a problem there might be special forms. In the older states where agriculture is on a well organized basis and where farm practices are standardized a special form of note book especially suited to these conditions could be utilized. However, these variations would be for notes on the soil types. The notes on the soil section, for individual borings or examinations could be made up that could be used universally.

It seems a prime requisite that the note book should be as large as possible, but not too large to be slipped into the ordinary larger pockets. It should be in such durable form that rough usage would do it no damage. It should be of loose leaf form so that pages could be filed in order under their proper subject groupings. I believe it would be better to have the pages perforated at the ends so they can be torn out. The outside cover should be of board or stiff leather constructed in such a way that the printed page pads could be inserted inside the cover and held there until necessary to remove one or all the pages for making room for a new pad. The pages should be numbered inconspicuously in one corner of the page. Between each two printed note forms there should be a blank page for the purpose of writing such additional miscellaneous notes as would seem necessary. After the notes are completed and filed they constitute a valuable record of very complete information in the most accessible form.

It will be noted that the page on notes for the examination of the soil section is arranged to take care of one soil examination. However, if there are minor variations in depth this can be shown graphically by marking the note "composite" for several examinations within any given small area, The variation then is shown by drawing a line across the profile section to show the range in thickness of each horizon. After making a number of page descriptions for individual examinations a master note can be made up from these on one of the pages, which will show at a glance the variations of the type

throughout a large area.

The profile page has been arranged with a view of giving a place for a complete description of a soil section. First, the date, then name of type, and location. Possibly a place should be given for writing the name of the person making the notes but this can be written on the margin anywhere if desired. The next note is entitled "condition of soil". This should be filled by stating whether the soil is cultivated, fallow, or an abandoned field, or virgin soil. Possibly it could be stated under this heading whether the soil is moist, wet, or airdry, though the moisture condition will be divulged in the succeeding notes. The next outline "position" refers to the topographic position of the location where an examination of the soil is made. Obviously there will be minor variations in most soil types depending on the position of the type where the examination is made as on a flat area, a gentle slope, a steep slope, or in a depression.

It will be noted that the faint blue lines on this note page are 36 in number, every 6th number and line being slightly heavier to facilitate reading. These lines represent the vertical soil section to 36 inches. When making a note a line is drawn along whatever line represents in inches the depth of each horizon and the proper descriptions are written above the line under the headings, or if the note is a composite the lines are drawn diagonally across the page to represent the variations in the thickness of each horizon or layer of soil.

There are three columns for subheads under "color" and "structure". Ordinarily only one of these will need to be filled in, depending on the state of the moisture in the soil at the time. Of course simple tests in wetting and drying the soil in the field would enable the field man to fill out all of these subheads for each soil examination, but this would take a little time and doubtless other examinations would divulge these points at various times during the season under various conditions of moisture in the same soil type. Noting the reaction of the soil to hydrochloric acid is of course an important point. The note headings "water holding capacity", and "penetrability", are subjects that probably may be interpreted variously by different field men. These characteristics of a soil are capable of only very general approximation by the field man, but notes of the apparent features along this line should not be omitted. It is probable that the bottom of the page should be reserved for notes and brief descriptions of the substratum below the 36 inch soil section to as deep as can be ascertained.

It should be mentioned that this note form is intended as an aid to the field man in the collection of complete data in the field and it should be in such shape as to make its use feasible and of practical worth. It is often easier to outline an ideal program than it is for the field man to comply with it. Therefore the practicability of such note forms should always be kept in mind in arranging them.

The reverse side of the note book page contains an outline of note heads of subjects most important to secure. While it is best to secure these data in places where the soil examination is made and noted on the soil section page, this is not always possible nor is absolutely essential.

We have found in Texas that it is very satisfactory to dig some large and deep holes in studying the vertical soil section. In fact during a large part

of the season in western Texas it is impossible to use a soil auger on account of the extreme hard, baked condition of the soils when the rainfall is light or during long periods of no rainfall whatever. This condition may be present in all the virgin soils all the time except for short periods after heavy rains. The photograph illustrates the complete outfit we have for surveying soils, including the digging tools. The time required for two men to dig a hole depends on the soils largely as some types can be dug into more easily than others. It is somewhat remarkable that some fine sandy loams are more difficult to dig into, when very dry, than the clay loams. The digging tools consist of a pick, a sharp straight spade, known locally as a sharpshooter or post hole spade, a spoonbill post hole digger, and a sharp crow bar. Two men dig a hole 3 to 5 feet deep in almost any of the soils in from 5 to 15 minutes. Naturally in a region where the soil types are very intricately associated the digging of holes would require considerable time and it is recommended that large holes be dug only occasionally for study of the soil section while the auger is used as an adjunct for the rapid examination of types already well known. In other words, map the known types by using the auger, but study the soils by digging holes--and if a very careful examination is desired--the bigger the hole the better. In one hole in western Texas where in search of a hardpan layer a hole was dug nearly 10 feet deep. More recently, with the inspector, a hole was dug 11 1/2 feet deep. We have found one of the best digging tools to be a crow bar made at a slight expense by sharpening a discarded Ford driving shaft.

Discussion.

Discussion of Address - "Outlines and Systems of Collecting
Adequate Field Notes" - W. T. Carter, Texas.

Professor Miller -

"How much use is the man to make of this every day?"

Mr. Carter -

"He makes one of those for every boring, or makes several borings within a short area and by drawing diagonal lines shows variation within a small area. One of the main things about this is that when a man goes to write the report he has before him a picture of the soil."

Dr. Marbut -

"Do you actually fill out one of these for every auger boring?"

Mr. Carter -

"No, we don't."

Dr. Marbut -

"Mr. Carter's plan of notes here and his statement in his report are inconsistent. You limit your soil depths to 6 inches - - - -

Mr. Carter -

"I stated that on the other side I have a description, but that should be at the bottom of the page right under the 36 inch layer."

Dr. Marbut -

"I would suggest that you just scratch out the 3-foot section of the profile column. Why limit the section to 3 feet? I would strongly suggest that you just scratch out that and what you mean is soil profile down into the substratum clear to the bottom, if that is 20 feet deep, and this will make your description elastic and you can describe your soil profile. One other suggestion--I would put that for the horizons of the soil profile and not make a column for every inch. There is no necessity for describing every inch, but there is necessity of describing every horizon in the profile and your color and structure and the rest of the characteristics. Did you find, for example, in any of the soils any advantage in describing every inch of the soil?"

Mr. Carter -

"No, we don't describe every inch. We just draw a line along one of those pencil lines and the note is finished regarding the depth of the horizon."

Dr. Marbut -

"Suppose your No. 1 horizon is three inches thick, then you draw a line through the three-inch mark?"

Mr. Carter -

"Yes."

Dr. Marbut -

"Then that would be all right if you take out that 36 inches. Can't you take out some of those heavy lines? In no instance have you a soil which has only one horizon. Couldn't you take out, just for instance in horizon 1 and horizon 2, take out the small lines representing inches, and write a little fuller description?"

Mr. Carter -

"That is what I stated. I think we ought to leave a space below to put in a description of the substratum."

Dr. Marbut -

"You are not doing what is absolutely necessary unless you do get a description below three feet. Just a little modification will make it an excellent thing, some basis upon which to base your soil description."

Mr. Taylor -

"I have tried to find an easy way of writing up soil descriptions. This last summer I have made a habit of locating good excavations for studying the soil sections. I find that I can get a much clearer idea of what the soil section is. The different soil layers are bound to be more or less mixed.

I have just come from the Buckeye Traction ditches and I have made a habit of keeping up with them and following their track when it was open. There I could get a better idea of the soil sections than almost any other way. Those trenches will go right across a field sometimes for a quarter of a mile, and in the area I was in, that trench might pass through as many as twenty different types of soil. It gave me a splendid comparative study and in filling out one of these outlines I would feel that I wouldn't care to go to that trouble unless I could have a soil section of that nature where I could see from the top to the bottom. It is better where one can get right down into the trench. These vary from 3 to 5 feet deep.

"Another thing, in taking notes in the field one wants to have things just as convenient as possible, and I have had a duplicate map, topographic sheets, cut up and mounted into a book, and on one page of the book I will have just the base map and on the other page I will have the map I am using to map the soils on. If there is anything special in the way of notes, I can indicate the location on the base map and indicate any suggestion on the outlines, and later on write up my notes. This greatly facilitated note taking in the field.

Mr. A. T. Sweet -

"There is one thing that I do favor very much, some system by which we shall actually get notes that we can use. Sometimes we quit so quickly that we don't get the notes we need. If we were actually required to write up six or eight or ten descriptions of each type, it would be much better than some are doing at the present time."

Mr. A. M. O'Neal -

"Dr. Marbut emphasizes the fact that in the humid region at least it is utterly out of the question to get the soil structure and also determine the character of the soil from our auger borings. The description of the soil type ought to be based on the soil sections or from a road cut or ditch excavation. It should be emphasized always in any soil description the statement whether that is virgin or cultivated and make your description according to the soil profile."

"Is it necessary to state how long it has been under cultivation?"

"No and yes, it would be information which would be of considerable value."

Mr. O'Neal -

"I think that the average field man doesn't take enough notes. One reason is that he is either too busy or thinks he is too busy. He puts it off until night to write up the notes of the day. I think Mr. Taylor's outline serves as a spur to make the man do these things. It is easy to fill in. I believe this note book is too large for the average pocket, though."

Mr. L. R. Schoenmann -

"On the matter of the size of the notebook, they gave all the men a big aluminum holder with a spring back and we found that it doesn't have to go into your pocket at all, Carry aluminum note books and enlarge the size of your sheets instead of diminishing them, they would be more useful."

Professor Hutton -

"Concerning the taking of samples, much more can be done with the spade. We find that even in that region which lies between the arid and humid, the use of the spade is very desirable. I think we will have to have the spade along all the time."

Mr. T. M. Bushnall -

"In the matter of the soil auger, I don't believe we ought to leave it out entirely. We can't expect to take time to dig a hole with the spade every three or four borings - - - - Our mapping is going to have to depend on the auger to a very large extent."

Dr. Marbut -

"I want to ask Mr. Carter what words he puts down in describing structure?"

Mr. Carter -

"We state whether it is compact or if it is cultivated, if it is crumbly, fine cloddy, small cloddy, or large cloddy. We state whether those clods are easily broken apart or not, just everything a man can think of in describing the condition of a broken-up soil. We use the term cloddy a good deal. You go down 2 inches and you have a very fine cloddy condition, almost a loam, but the texture of a clay loam, but it breaks up naturally."

Dr. Marbut -

"How large are the grains?"

Mr. Carter -

"About like small shot or buckshot. You have soil in that condition to about 2 inches then you have a large cloddy condition and then the mass breaks into a finer cloddy condition, maybe due to moisture condition or some arrangement of the clay."

Mr. G. E. Condra -

"What do you do with your original note books? Do you send them to the Bureau or keep them in your own files?"

Mr. W. J. Geib -

"We keep them and file them for reference in our files. We don't send them to Washington, as we have more use for them than they have."

"About the notes in the western states - In many of the surveys the report is written up and the notes are thrown in the waste basket. It is important that they be filed somewhere. At the present time there is a case pending in the U. S. court in Chicago in which I will probably be called as a witness. I have been unable to locate the original field notes for one of these areas; in the case of the other survey, I have been unable to locate anything at all."

Mr. G. E. Condra -

"I would move that the original field notes be put in a fire-proof vault either in the state office or in Washington."

Motion carried.

RELATIVE IMPORTANCE OF SUCH FACTORS AS COLOR, STRUCTURE, SOIL LAYERS, MOTTLING, LIME CONTENT AND ETC. IN SOIL DIFFERENTIATION.

By W. E. Tharp, U. S. Bureau of Soils.

We are considering the relative importance of some of the principal factors in soil classification throughout the humid regions of the United States. These include color, texture, structure, and other physical features apparent upon close observation. What right, so to speak, should be given each in making separations in the field?

After the physiographic position and general regional characteristics have been determined we suspect that most soil surveyors think of these criteria in about the following order: color, texture, structure, and deep subsoil conditions. This seems a logical sequence, color is important. As we all know it reveals much of the history of the soil. The presence of organic matter in the surface layer, and the depth and degree to which oxidation and moisture movement have taken place in the subsurface layers are almost invariably indicated by coloration. Quite true we may not always read these signs aright, but as indicators of important soil processes they are invaluable to the field man.

The criticism is sometimes made that we stress color too strongly in our classification. The farmer, quite naturally, estimates soil values in terms of crop yields, and this is true of most other people interested in lands from an agricultural standpoint. But in crop production many other variable factors enter, while we are trying to set forth constant factors, or those permanent features, of soils from which safe deductions may be made concerning their values.

To our friends who have not attempted soil mapping we will say that much of the difference of judgment relative to soil colors is due to variations according to moisture content and in no small measure perhaps, to misuse of color terms. We are greatly in need of more concise and uniform names for graduations in shades of brown, yellow, and gray.

Texture is important in so far as it influences cultural operations or moisture conditions, but field separations based entirely upon nice textural distinctions do not seem necessary.

Structure of the 3 foot section is important. The occurrence of a marked degree of compaction at some horizon or of any other pronounced structural peculiarity is usually so apparent in surface conditions, when compared with similar soils, that no question can be raised as to the recognition of such features as type distinctions.

It is the minor differences in the soil profile however that give trouble in soil mapping. They may be easily observed in a road cut or careful boring but hardly traceable across a field. Their recognition must depend very largely upon the degree of detail in the map. However, it is very easy to overlook the significance of some of the zonal developments. Since they are the result of processes taking place in the soil mass effort should be made to interpret their meaning. Can they be correlated with physical or chemical changes of any importance? In what degree do they tend to accentuate the effect of

very dry or unusually wet seasons? Should samples for chemical analysis be taken according to these structural variations? It is easier to think of these possible variations than to satisfactorily represent them, as we draw our soil boundaries. We have in mind certain types in which it seems very desirable to have the samples for chemical examination, taken according to well marked structural horizons.

The occurrence of calcareous material at depths of 6 or 8 feet is usually considered unimportant with respect to its influence upon the 3 foot section. But should we be too sure of this, particularly in those places where this substrata has such structure as to admit of deep and uniform diffusion of rainfall, while capillarity and aeration are seemingly effective to unusual depths. The presence of free lime within the 3 foot section is so comparatively rare in the humid regions that types possessing this desirable feature are worthy of careful mapping. Conversely the acid soils are so common that we may easily neglect this feature. It seems desirable to bring out strongly in our reports the lime requirements of acid types so far as this can be ascertained in the field. But in the routine of the days work there is a strong temptation to neglect simple field tests.

In conclusion we are not sure that the factors named have been taken up in the order of their importance to the field man--even if such an arrangement is practicable. Nor have all the criteria of soil classification been mentioned. In the discussion of this subject, we trust the opinions of other field men will be given as well as the views of investigators in other lines of soil work.

VARIATIONS WITHIN THE SOIL TYPE.

By D. S. Gray, Iowa Soil Survey.

The matter of variations is a very common problem that we all encounter in our field work and I am sure the mere mention of the subject brings to your minds innumerable personal experiences along that line. The situation has been handled in a more or less routine manner in the past, which has been generally satisfactory but there is undoubtedly still room for improvement.

Variations are frequently of considerable agricultural significance and their consideration has often been brief and inadequate. In instances where they influence the value of a piece of land to any extent they are surely deserving of being treated fully.

It is quite obvious, I think, that any advancement along this line must come from the field men, as it is they who are constantly in touch with the situation. There is no great uniformity in their disposal at the present time, due undoubtedly to the individuality of the man in charge of an area. It is his duty to note very carefully such changes and acquire the habit of taking a good many notes in the field at the time an observation is made.

There are a number of factors influencing soil variations.

Topography differing from that of the typical soil may very easily warrant a separation or distinction being made. This is especially true when it is such that it may require a very different form of management or give the soil a greater or less value. Color is frequently found to hold a close relation to topography and disposing of one usually cares for the other. Differences in depth of surface soil or underlying sections of the profile are sometimes of little consequence from a practical viewpoint. Where of significance from the standpoint of insufficient or excessive drainage or other such factors of importance, some recognition of their presence may well be made.

Slight textural variations are not of serious consequence and in such cases combining with the typical soil is advisable. However, where the difference is great it might best be classified separately, even at the increased cost in preparation of the soil map. Although I appreciate that it is always desirable to minimize that factor, I think that a failure to do this and the failure to separate such variations leads to confusion in the interpretation of the soil map.

Generally speaking, there are two classes of variations to be found. First, those variations which are of small extent or which are very local in character and usually occur as slight differences within larger areas of a typical soil.

This type of variation may come within the limits of the series with which they are included or they may be totally outside in this respect. Of this type we find their occurrence spotted and of such small extent that any form of separate management for their respective bodies would be impractical.

While it might be possible to indicate such bodies by the usage of a symbol, and in some cases this would be feasible, I believe that in general

such a practice would be impractical when the mechanical features of the soil map are taken into consideration. Being indicative of such small areas, there location should be very exact, and considering the scale of an inch to the mile used on our maps, they could not be used with sufficient accuracy to be of value. However, I believe that the use of the swamp and gravel symbols to indicate small areas may be considered a success.

The present system of disposing of variations of this type consists, as most of us know, of not showing them on the map but giving a description of their characteristics in the discussion of the type in which they occur. That is about as much attention as is generally given them, but is surely not always sufficient. I wish that it were possible to show these on the map. The outlining of their boundaries would of course demand unwarranted exaggeration but possibly the use of a symbol might be adaptable in some cases. I think that such variations are often important factors influencing the value of a piece of land and some indication of their presence and exact location would be of importance to an interested party that is not personally acquainted with that particular tract of land. Such variations are often factors of great economic importance, if, as they frequently are, responsible for the need of special treatment, machinery or increased difficulty in the seeding, cultivation and harvesting of a crop. Their consideration in a discussion of the type should be very specific as to the exact location in which they occur and any special economic results for which their presence may be responsible. Where their characteristics more nearly approach the typical soil and their management is more nearly the same, less emphasis need be given them.

It is very common to find another type of variation within this class. That is a variation which exists in large enough bodies to be mapped. These may differ sufficiently from the typical soil to require a different form of management. Such being the case and they are not deemed sufficiently variable to warrant the establishment of a new series, or mapping as a phase their exact location may very easily, and should in all cases, be given. This requires the taking of notes in the field, which are, incidentally, the field man's greatest asset when it comes to the report writing.

Some cases may be cited, I am told, where the field man has mapped a body of soil separately and given it a separate classification from another soil with which it is later thrown by the final action of the committee on classification and correlation. This is after the report has left the field man and in its final copy no mention of this area is made, the only action being its inclusion with another soil occurring in the area. It is not fair that variations of agricultural significance be omitted from specific mention and location, either by failure of the report writer or the possibility just mentioned, when they occur in bodies large enough to be shown. This fault lies largely with the field man who at the time of report writing recalls that certain variations exist but beyond a brief mention of them they are given no further consideration.

The failure to give specific information regarding a marked variation which occurs sufficiently large to map throws a bad light on our work. For instance, in the area I have just completed a good deal of Clyde silt loam was mapped. This characteristically has a heavy subsoil but a few bodies of considerable extent were encountered which were underlain with sand at thirty inches. A novice reading the report and having noted such an area would think the work poorly done if no mention were made of such variations. Such

an instance of greater agricultural significance formerly occurred within the Carrington series as mapped in several areas in Iowa. Bodies of the type were found possessing a sandy or gravelly subsoil giving it a drouthy character wholly foreign to the typical soil. You can readily see the wide difference between the two soils. Still, in some areas where this variation occurred, it was not even mentioned let alone being given exact locations. In 1920, however, the Dickenson series was established which includes this type of soil which was formerly mapped as Carrington.

Is it fair to include such variations with a typical soil? Certainly it is not, for the variations of lesser value degrade the typical soil and those of a more desirable nature are also done an injustice. This is entirely out of harmony with the aim of soil mapping and may be benefited to a large extent by a more judicious consideration of them by the field man, and cooperation from those who pass on the final correlations.

Secondly, we encounter those variations in soil types which may be slightly or materially different from the soils of some series already established. Frequently they are mapped as an established soil which they most resemble and a description of the soil and its location given. This will often suffice. However, I believe that mapping separately is more feasible, giving more accurately the extent and specific location.

The Waukesha and O'Neill soils, which are of terrace occurrence, are something of a parallel to the Carrington-Dickenson case previously mentioned. The Waukesha soils are dark brown in color, underlaid by slightly heavier subsoils. Naturally drainage is good but not excessive and they are highly prized for general farming. The O'Neill soils also possess the dark surface color and the upper subsoil is similar to that of the Waukesha, but the lower subsoils are stratified sand and gravel and dissipate moisture quite readily, giving it a much lower crop producing power. The necessary distinction is obvious but only until a few years ago did the same difference serve as a basis for the establishment of a new series in our upland glacial soils.

The matter of phase mapping is in direct relation with the subject of variations. While they have their drawbacks they are commendable in many ways. Just what type of variation will warrant the mapping of a phase? It has been known that certain phases have been mapped which were really the basis for a new series, being established. In such cases they have been of great value by giving a consistent character to the work.

Some means of attempting to stabilize the mapping of phases might be of value. Since the individuality of the field man is a factor in such matters, there is liable to result some confusion in their interpretation. Variations of the same name between different areas might not be approximately the same. The organization putting a man in an area could frequently assist him very much through supplying some specific information regarding the soils in that particular area.

The limits of the official descriptions of our series are often far enough apart to include wide variations of agricultural difference. This brings up the mapping of soils in different areas bearing the same name but differing materially. Had one or the other been mapped as a phase, the difference would be very easily explained and no questions raised. The Carrington series for

instance has been mapped as the typical soil, rolling phase and steep phase. What is a typical Carrington soil? That might be an unanswerable question but I think the field man generally considers that form having the highest agricultural value as being typical. This might then give the impression that a phase of a soil is probably of less value than the typical, but such is not necessarily true.

The Muscatine series is now accepted as a flat loessial soil having a mottled yellow and brown subsoil. It formerly included what is now called the Tama series which in reality is merely well drained Muscatine with some gentle roll to the surface, good natural drainage and a solid yellowish or brown subsoil oxidized of the mottlings which occur in the former. Before its establishment as a series I have known it to be mapped as rolling phase Muscatine. Another point in favor, and it is a simple matter to explain to someone not so familiar with the work that what is now Tama used to be rolling phase Muscatine, and if he knows one he knows the other.

The Clinton series of soils are also loessial in origin and is, broadly speaking, just light colored, rough and shallow Tama soil. The two soils however represent two different series.

The differences between these series are no greater than the variations which occur within other single series. Surely then what is true in one place should hold in another and if variations of such character are found they warrant separation at least as a phase. In the area I have worked in this year we encountered a variation in the O'Neill worthy of mention. This series generally includes terrace soils underlaid by loose sand and gravel at eighteen to twenty-four inches. This variation, of which I speak, however, does not reach material until at about thirty inches. Above that depth the soil is identical with the Waukesha series which are of much greater value than the O'Neill soils. The variation was mapped as deep phase O'Neill and with its deeper silty layer is more fertile, drouth resistant and productive than the typical O'Neill, of which a good deal occurred in the area. If mapped as the more typical O'Neill it would have been done a great injustice. Is it not fair that such differences be dealt with in a detailed manner rather than mapped as the rest of the soil receiving little or no special mention?

To what extent should features controlled by man enter into the separation of a phase? Such changes in a soil may be of great significance in its value. I speak of such factors as drainage and timber growth. It is a very questionable matter when it comes to the indicating of them on the map, because of their possibility of reclamation.

In Iowa, we have for instance the Clyde and Webster series. These are naturally poorly drained and unsuited for putting under cultivation. They support a growth of wild prairie and water-loving grasses affording pasture and wild hay, which are far from the best. With the establishment of good artificial drainage they produce excellent yields of the common crops. We have also the Clinton silt loam which is naturally a timbered soil. Not meaning to belittle the value of a good woodlot, there are many areas of this soil still in timber which would not be too rough to put under cultivation. While not as desirable as some of our other loess soils, areas suitable for cultivation will produce very profitable yields under proper management. Since, however, these factors are subject to change from year to year it would be difficult to treat them specifically, yet they are deserving of consideration.

It is rather difficult to state concretely what should constitute sufficient cause for the establishment of a new series or when a variation becomes so great that it is no longer a variation but an entirely different soil. This is perhaps something too greatly anticipated by the field man but held in check by the inspector who has, I am sure, dashed the hopes of many a field man of having found a new series. Not to be too critical, however, I think that there is possibly too great a tendency on the part of the powers that be, to combine a variation with some established soil rather than form a new series. I can readily see the desirability of doing this whereever possible but I feel that it has developed into a practice of making some rather hazily developed series into a dumping ground for new soils found. I think this is illustrated in the fact that the same series as mapped in different states differ materially in characteristics and agricultural values. (This statement is based on hearsay rather than personal observations.)

I do not wish to give the impression that I am extremely critical regarding our present practices in relation to soil variations. Some of the problems encountered are difficult to overcome and the present means of handling them are quite satisfactory but I believe there is room for improvement and it should come largely through the field men applying themselves more thoroughly.

Discussion.

Discussion after Address "Variations within the Soil Type" - D. S. Gray.

Dr. Marbut -

"Mr Gray referred to the difficulty that field men had of getting a new type recognized, admitted, at the office. Now let me say this, I believe there never has been a case where in any considerable area, where when a field man presented the case in a concrete form, I do not believe there has been a case where it hasn't gone through. Now if Mr. Gray or any one else has a new type and can tell why it is different, giving the soil profile, it will be given consideration."

Mr. Gray -

"I didn't mean to be unjustly critical. I recognize there is no logic in recognizing a type when there is only a small area of it. In talking with other field men, I find that they have entertained the idea that they have possibly established a new series, and that is not always the case. - - - - "

Dr. Brown -

"In connection with the discussions of whether small variations of types should not be included in the reports, there is a certain amount which should be included in the report. There are modifications, variations, which are not extensive enough to be separated into even a phase, let alone a type, and those descriptions are going to be of considerable help from the agricultural standpoint and they are going to obviate a lot of our difficulties in explaining our maps. The discussion should include not only the bare description of the soil type itself, but a complete statement of the important variations and where those variations occur."

ACIDITY TESTS AS AN AID IN SOIL SURVEY WORK LABORATORY VIEW POINT

By S. D. Conner, Purdue Agricultural Experiment Station.

One of the main reasons why a soil survey is worth while and may be justified as an expenditure of public money, is that it furnishes information about the agricultural value of different types of soil. If a soil survey is to give adequate agricultural information, it should be so made that it will distinguish soils of different productivity and of different fertilizer and lime requirements. This is particularly important in the humid sections of the country.

In this connection, I wish to state that any arguments in this paper in favor of soil classification for the purpose of distinguishing agricultural needs, should not be construed as an argument against any other type of classification which will serve some legitimate purpose.

No one test is as valuable in diagnosing the deficiencies of a soil, as an acidity test. A good acidity test not only tells whether a soil needs lime or not, but it gives a very good indication as to the phosphorus needs. In almost all instances, soils in need of lime, also are in need of phosphate. Quite often black soils high in calcium carbonate also need potash. It is true, however, that some acid soils also need potash. Every soil specialist should become familiar with the needs of the soils in his State or section, in relation to acidity and other tests. If it is known from what section a soil comes, it should not be necessary to make a complete chemical analysis to give a fairly accurate diagnosis of the soil needs.

In addition to acidity tests, it is absolutely necessary to take into consideration two additional factors: namely, the reaction of the subsoil and the organic matter content of the soil.

It is just as essential to know the reaction of the subsoil as it is the surface soil. With many soils the only apparent reason for crop success or failure, is due to the character and reaction of the subsoil.

At this point, it might be well to admit that there are no chemical methods that will infallibly show from a mere analysis, just what a soil needs. This is true of physical tests and classifications also, but if you have along with the chemical tests, a modicum of experience and a fund of good judgment, it will be possible to diagnose fairly well the more important needs of the majority of soils.

For purposes of agricultural classification, soils should be divided into those high in organic matter, and those low in organic matter. This division may be nearly always made by observation of the color of the soil. The reason this division is so important is that acidity in organic soils is very much less harmful than acidity in light colored soils. In fact, many soil acidity tests are worthless when used alone to measure the acidity of dark colored soils. Fortunately there are some methods which measure inorganic soil acidity and which are affected, but very little, by organic soil acidity. The potassium nitrate test for soil acidity developed by Hopkins, Petit and Knox, is one of the best methods known for measuring mineral acidity in soils. Even this method, however, can not always be depended upon to give the correct

index as to whether a dark colored soil needs lime or not for crop production. Given, two soils of equal mineral acidity and different organic acidities, then the soil with the highest organic acidity needs lime the least. In other words, the organic acidity not only does not increase the toxicity of acid soils, but it has a buffer action on the mineral acidity and acts in a protective way to a certain extent.

While the Hopkins' method measures not much besides mineral acidity, the Jones' Calcium Acetate method measures both mineral and organic acidity. If we determine both the Hopkins' and Jones' acidities then substract the Hopkins' from Jones' acidity, we have a good approximation of the organic acidity. By using the formula $\frac{H^2}{J-H}$ an index is obtained which is a very good indication of the lime requirements of the soil for crop needs. It is the only method so far used that has worked without exception on all the Indiana acid soils which have had their lime requirements determined by means of crop tests. This formula, which is approximately the square of the mineral acidity divided by the organic acidity, is based upon the same principles that Ostwald's well known dilution law is based. Ostwald's formula is used to measure the strength of acids. It is the square of the active, dissociated acid divided by the nondissociated or nonactive acid.

Of course it should be understood that acid soils often need other correctives besides lime, sometimes even more than they need lime. For this reason it is quite important to make a study and become as familiar as possible with the peculiarities of the soils of different sections. Fortunately for the fun of the game of soil investigation, new soils and new problems are constantly being brought to our attention.

To illustrate some of the points I have tried to bring out in the paper, I present two samples of fine sandy loam, both of which are entirely unproductive in the natural state. The sample marked "R" is from the Rensselaer Experiment Field. This soil contains about ten tons of calcium carbonate per acre. It of course needs no lime. It will average about three bushels of poor corn per acre when untreated or with any combination of nitrogen, phosphorus and lime. When an ample supply of potash is used alone or in any combination, the yield of corn is forty to seventy bushels per acre. This type of soil was mapped as Clyde fine sandy loam in White County, Indiana. However, not all areas mapped as Clyde fine sandy loam are so deficient in potash as this soil.

The soil sample marked "W", which has about the same texture and organic matter content as "R", is a very acid soil, entirely unproductive without lime and phosphate. This soil needs about ten tons calcium carbonate per acre to entirely satisfy the total mineral and organic acidity in it. Two tons of limestone together with acid phosphate is sufficient for crop requirements, however. This soil which is from the Pinney-Purdue Experiment Field at Wanatah, was mapped as Newton fine sandy loam in an adjoining county. The Porter County write-up of this type is as follows: "Typically the Newton fine sandy loam is a desirable soil, comparing favorably with the heavier soils in crop yields, but in Porter County crops on this type do not do so well as elsewhere. The soil seems to be in an extremely acid condition". This type of soil was also called Newton fine sandy loam when Lake County was surveyed one year later. Newton silt loam was used as the name of a soil not in need of lime in Lake County. Apparently Newton loam is a quite acid soil in Lake and Porter Counties, while Newton silt loam in Porter County is not particularly

in need of lime. A small area of this acid fine sandy loam was mapped in Kosciusko County in 1920 as Maumee fine sandy loam. Field samples were afterwards taken of this area and tested for acidity. It was at once seen that it was misnamed, and in a recent revision this area was changed to Newton fine sandy loam. There are in Indiana, over sixty thousand acres of such soils which should have a distinctive series name. At Wanatah this so-called "hog prairie" runs from a loamy fine sand to a loam. Possibly in some sections there is a fine sand. We have always called it the Wanatah type of soil, because no other name seemed to be distinctive of it. Whatever it is called, it would be of very great value to farmers, county agents, and soil men in general, for it to have a name that was descriptive of its agricultural needs. The same thing could be said in regard to the fine sandy loam of the Rensselaer field type. This soil is called by farmers "bogus soil", or "alkali soil".

There is no need to present illustrations of all types of soil, except that it does seem very important that peat or muck should be differentiated. Europe has its high moor and low moor, which represent types of muck or peat of different agricultural needs. I have here two samples of muck from Kosciusko County taken one-half mile apart. They are as different in their needs as it is possible for two soils to be, yet these types have always been called by one name. A farmer does not need to be told they are muck, he wants to know what they need. A blanket recommendation is misleading. One soil, the dark brown one marked "S", needs lime and phosphate. It will absorb about 40 tons of limestone per two million pounds soil, although it does not need this much for crop production. The black muck has about fifteen percent calcium carbonate in it and needs potash alone. It is not always possible to tell the nature of a muck by the color, although as a rule in Indiana the brown mucks are more acid than the black mucks. In classifying muck soils, there are many intermediate grades between these two extremes. Some mucks need lime and phosphorus, some phosphorus alone, some phosphate and potash, and some potash alone. The matter of nitrogen needs is to a large extent climatic. Few Indiana mucks respond to nitrogen except for early sown onions.

To Summarize. Soils should be so classified that agricultural needs may be shown. Among other methods of soil classification used, a good acidity test should be made on both surface and subsoil.

Organic soils should be considered in acidity tests differently from mineral soils.

Discussion.

Discussion of Addresses "Acidity Tests as an aid in Soil Survey Work" -
S. D. Conner and T. M. Bushnall.

Dr. Marbut -

"I would like to hear some of the chemists discuss both of these papers. Are there any who have used any acidity tests in the field other than the hydrochloric acid?"

Mr. Veitch - - - -

Dr. Marbut -

"Has anyone found that a worn soil will be acid or will not be acid?"

Mr. Conner ? -

"Several years ago we collected about 30 samples of virgin and cropped soils and found that there was practically no difference in acidity as measured by the ordinary methods. There was 27% loss of nitrogen in the cropped soils, and 44% in ammonia-soluble organic matter. These soils need lime worse than the virgin soils. The change in the actual acidity was so much it was a change in fertility."

Dr. Marbut -

"Of course you would expect that. Have you any data to show whether the profile was different?"

Mr. Conner -

"I don't know anything about the profile."

Dr. Marbut -

"Then it is not proved that the profile method is not satisfactory."

Dr. Brown -

"A few years ago each one came with a little better method of his own for determining soil acidity and each one told of his own method and they almost had a riot. The situation has not changed much at the present time. Everybody has his own method for determining soil acidity and everybody believes that his is the only method to get results. I have tested many of the methods and no two agree on any number of soils. We are still very far from a solution. We do get indications from qualitative results, we get indications in our field work that we can test the soil for lime and get actual results. The field men can offer considerable help by testing the soils in the field. I might suggest that the Committee on Laboratory Tests might be instructed to include methods for determining soil acidity."

Dr. DeTurk -

"We have made tests on cropped and uncropped soils on a number of experiment fields. We have made KCNS tests on the untreated plots and upon grass borders and lime plots, and we have found that the grass borders and lime plots are not acid, while the others show great acidity."

---------- "If the hardpan was near the surface, the soil was very acid. If the hardpan was down to two feet, the acidity was very low, though it would require about 2 tons of ground shell. A county agent informed me that in this particular soil there were a great many spots in the field that were non-productive and he said he had been unable to find an explanation. I told him that I found a great many of those non-productive spots but found none

which I was unable to explain. He had examined the soil section and there was no difference between the productive and non-productive spots. We arranged for a trip and made a number of examinations, and in every case in the non-productive soils, we found this acid hardpan very close to the surface, from 12 to 15 inches, sometimes even 10. The soils were extremely acid and required about 6 tons of ground shell. There is a relation between the soil section and degree of acidity."

ACIDITY TESTS AS AN AID TO SOIL SURVEY WORK
Field Man's Viewpoint.

By T. M. Bushnell, Indiana Soil Survey.

In defining the field man's viewpoint in regard to acidity tests, it should be remembered that his chief function is to map soils largely on the basis of the physical appearance of the soils themselves or differences in the vegetation they support. However, these types which are separated on physical appearance are sampled and subjected to chemical examination, the results of which may or may not check field observations. In case of disagreement the field man may feel that the small samples analyzed do not truly represent the millions of tons of earth that he has viewed. Or, if the chemical analyses do seem to teach important lessons which should have modified the mapping, this knowledge usually comes too late to benefit the area from which the samples were taken. The field man should know more about the chemistry, and in fact, more about all other factors entering into soil differences during the progress of work, so that he may weave these ideas into his mapping, and also be better qualified to judge the reliability of laboratory tests.

At this point my remarks might be entitled "Confessions of a Field Man", as I happen to be the one who was in charge of the White, Porter and Lake County surveys mentioned in Professor Conner's paper. Although when White County was mapped in 1915, the field men in this county had never previously mapped an acre of any of the soil types found in the area, and, for them, it was all pioneer work, the presence of spots of "bogus" land were noticed (and mentioned in the report), but they were considered too small and indefinite to map. Possibly a few areas of such soil large enough to map, were overlooked, especially in some extensive marshy meadows where such indications as poor corn, and white salts encrusting the surface were of course not in evidence. Also at that time there was no Rensselaer field to demonstrate the facts about the "bogus" land. In the light of what is now known about "bogus" land, its profile, and any other facts which might definitely identify it, should be determined. Even if it occurs in areas too small to map, all the known facts about its nature and needs should be stated in a report of any county where it is found. Probably we should give more attention to mapping other phases and variations of soils which may be of comparatively minor importance in a county, yet which have some striking features which impress all who observe them.

The question of acidity in the Newton soils in Porter and Lake Counties, has been a thorny one. I must disclaim personal responsibility for the statement in the Porter County report that, "typically, Newton fine sandy loam is a desirable soil comparing favorably with the heavier soils in yields, etc", because, even yet, my experience is limited to the acid and comparatively poor varieties of this type. Also a soil was correlated as a Newton silt loam, heavy subsoil phase as an economical way of disposing of an inextensive type, in spite of my repeated protest that it did not belong in that series.

I must confess it is improbable that the signs of acidity in Newton soils would have been noted so carefully if I had not had personal acquaintance with the Wanatah experiments. It happened that the party which mapped Kosciusko County was not acquainted with the Wanatah work, so it is not strange that the

acidity of a few small areas of Newton soils did not make much impression on them. While I believe it is true that the same influences which produce the typical Newton profile, also tend to produce soil acidity, it is probably true that the heavier types are less acid than the sandier ones. This would be nothing unusual, as we often observe more agricultural difference between different types of a certain series than between two similar textured types of different series.

In the particular counties under discussion, the relation of acidity to soil types could have been worked out far better if the field man had had a good acidity test instead of having to rely on general indications.

For field use the ideal acidity test should be easy, simple, quick, cheap, and should give fairly accurate quantitative results. As liming recommendations are usually made with a ton per acre as a unit, and the general policy is to give a surplus over actual needs, an acidity test showing lime needs to 1000 pounds per acre, should be accurate enough for ordinary purposes.

Some of the methods which have been tried in the field, are litmus paper, brom thymol blue, potassium thiocyanate, and the Truog method. The first three methods are qualitative methods of varying merit, and the last is a quantitative method with which a test can be made in about 15 minutes.

The KCNS method gives such a wide range in the shades of color formed by different soils that it seemed to have some promise as a quantitative colorimetric method, although Dr. R. H. Carr found that the colors developed by this reagent by various acid soils, do not have much relation to the results of his titration method, which checks the results of the Veitch method. However, a modification of Comber's test will be described for your consideration.

This test involves several simple pieces of apparatus which includes a sampler, one-half inch test tube, graduated pipette, and a set of color standards. To these might be added a sample box. A complete set might be enclosed in a cigar box. The sampler used is simply a 38-caliber brass shell with the cap-seat reamed out and a plunger inserted, which leaves room for samples one-half inch in length. The soil is sampled by pressing this sampler against a clod of earth, smoothing off the end, and pushing out the plug of soil. Theoretically, a sample taken by volume should give results more proportional to an acre of soil than samples taken by weight, because of various specific gravities. These plugs will usually hold their form except in the case of very light textured, or dry pulverized soils. A number of them can be carried in one test tube, so one-half dozen 6-inch test tubes in the vest pocket will allow a field man to bring in 60 samples from one hike. The test tube may be labeled to identify the samples, or a slip of paper with a description inserted in the tubes. There are a number of simple ways of keeping records of these samples, which may be varied according to circumstances. These samples may be tested in the field, but since moisture interferes to some extent with the test, it is best to have all samples in an air-dry condition for testing. Each sample plug is put in an individual test tube. Two cc of 95% ethyl alcohol containing 4% KCNS is added to each sample. The tube is corked to prevent evaporation and allowed to stand one day. The plug should not be broken up, as pulverizing will not effect the color appreciably, but will make the solution cloudy and also make the test tube more difficult to clean. The colors developed in the test tubes are compared to a color standard. This standard was prepared in ten different dilutions which number from one to ten. If it

is assumed that each unit in this scale is equivalent to a lime need of 1000 pounds per acre 6 inches, results obtained do not show any close relation to results obtained by other methods, although they roughly parallel the figures obtained by the Jones' method which shows combined organic and inorganic acidity. However, if 1 cc of pure distilled water is added to each test tube, the original color is reduced by very different degrees in various soils. When the resultant colors are compared to this same standard and each unit of the standard scale is assigned a value of 500 pounds per acre, the lime requirements of soils by this method have checked the Hopkins' results from the same samples, within 500 pounds nine times out of ten, so far as it has been tried. The figures obtained from the original shade of color and the reduced color, may be used in Professor Conner's Mathematical formula for determining lime needs of a soil. As an accurate determination of soil acidity or lime requirements, this test will stand or fall with the other methods whose results it checks. Its importance to the field man lies chiefly in the fact that he can easily take and handle dozens of samples at one time and can make 50 to 150 tests in an evening.

While this modification has been tried out on a variety of soils with enough success to encourage further observation, it is described at this time chiefly with the view of giving others a chance to demonstrate its value or limitations. At the present time certain limitations are apparent. For instance, it has not given very satisfactory results with the few samples of acid mucks which were examined. Also, in a few cases such as the deep subsoil of the Cincinnati silt loam, this test shows only half or two-thirds of the acidity shown by the Hopkins' test. A number of points connected with the use of this modification are far from being definitely determined, the subject of a good standard being one of them. However, it is hoped that we can soon determine about the range of usefulness of this method and the best way to handle it.

The ease in which the KCNS test can be made and the large number of individual samples which can be handled, enables one to get a wider knowledge of the variations occurring in the field. Some rather suggestive tendencies have been noted, especially in the matter of distribution of acidity throughout the profiles of different soil types, and the variations in acidity under different drainage conditions.

DRUMLINS AND THE PROBLEMS WHICH ARISE IN MAPPING THEM.

By H. G. Lewis, U. S. Bureau of Soils.

Preface.

The contents of this paper is based on field observations of the Drumlin Belt of New York, with available data published by the New York State Museum. The data submitted for southeastern Wisconsin is taken from Soil Survey Reports of Fond Du Lac, Jefferson, Waukesha, and Columbia counties, and from the Geology of Southeastern Wisconsin, By William C. Alden, of the U. S. Geological Survey.

Area of Drumlins.

The typical Drumlin Region of New York is confined to the north central part of the State. It extends from near Oswego on Lake Ontario southeast to, Syracuse on the east, and Albion and Batavia on the west. The Belt is bounded on the north by Lake Ontario and extends to the south between 30 and 40 miles, the southern boundary conforming roughly to the northern ends of the various lakes, comprising the Finger Lakes Region of the State.

The Drumlin Region of southeastern Wisconsin is confined largely to the area south of Lake Winnebago, extending from Fond Du Lac on the north, Madison on the southwest, Whitewater on the south and Waukesha on the southeast, Watertown lies near the center of the main Drumlin region.

Origin of Drumlins.

The origin of Drumlins as yet has not been satisfactorily determined. Professors Chamberlain and Salisbury are of the opinion that they were formed by an accumulation beneath the ice under special conditions or by erosion of an earlier drift or perhaps influenced by longitudinal crevasses or fissures in the ice lobe. Dr. Fairchild of the University of Rochester, who has done considerable work in the Drumlin region of New York says, "Drumlins are shaped by the sliding movements of the lowest ice, that in contact with the land surface. This fact implies that the whole thickness of the ice sheet participated in the motion". He goes farther and states that the Drumlins were built up by the addition of materials or a plastering on process.

A careful examination of a section through the Drumlin hill or ridge shows little or no stratification of the materials, showing that flowing water under the ice did little or no work in building up the mound. As compared to a cross section of kames and eskers, which are the work of flowing water under the ice or at its margin, the Drumlins are quite different, showing no assortment, while the former shows evidence of assortment and stratification of the materials.

In some few cases near Port Byron and Weedsport New York, the base or lower slopes of the Drumlin hills show exposures of the underlying shales. These shales give rise to a reddish to pinkish colored soil which is largely residual in origin and is classified as Lockport Soil Series. In places the reddish to pinkish color or tinge of the Ontario soils is due to the shale influence. Near Syracuse, New York, the base or lower slopes of some Drumlin

hills show exposures of limestone rocks. Some of the earlier theories of Drumlin formation, was that the core of the mound was rock and the glacial till had been deposited around the rock core. Exposures of rock at the base or around the lower slopes of Drumlins are not common, and cross sections, as observed in railroad cuts and roadways show unassorted till to a depth of 20 to 50 feet or more with no evidence of a rock core.

It is generally accepted that Drumlins were formed under the ice under special conditions favorable for the deposition of till similar in structure to that of the ground moraine.

Topography of Drumlins.

From the standpoint of topography the typical Drumlin has a very marked topographic outline. In shape the Drumlins are usually elongated ridges from 1/2 to 2 miles or more in length, with some few 3 to 4 miles, the longer or major axis being parallel to the direction of ice movement during the Glacial Period. These ridges or ovoid shaped hills are more generally 1/4 to 1/2 mile wide, usually the width being approximately one-third the length. In many places the Drumlins represent nearly round hillocks or knobs.

The north facing slopes are usually steeper and more broken than the sides of the ridges and the southern ends are more gradual, tapering down to comparatively smooth topography. The crests of the ridges or hills vary from 50 to 250 feet in elevation above that of the surrounding smoother parts. The ridge crests are often sharp to rounded, breaking away on either side to comparatively gentle slopes.

In certain sections of the Drumlin Belt of New York, between Syracuse and Rochester there are thousands of these hills lying on either side of the New York Central R. R. When viewed from a distance, on a clear day, these hills present a billowy appearance and one can count 50 or more distinct hills or ridges. The Drumlin Belt of New York is considered one of the finest exhibitions of this peculiar surface configurations in the World.

The typical Drumlin hill s of southeastern Wisconsin are very marked and in the region east of Fond Du Lac, near Johnson Creek in Jefferson county and in the eastern part of Dade county these hills or ridges form a conspicuous part of the topography.

The north facing slopes of the Drumlins are usually steeper than the sides or the southern end, which is usually gently sloping. As the ice moved from the north, one naturally thinks that the north facing slopes would be more gradual than on the south, however this is not the case. In my observations, it has occurred to me that perhaps the steepness of the north facing slopes of the Drumlins are in some way related to the action of water or wave action, similar to that going on at the present time along Lake Ontario in which truncated Drumlins are being formed. The north facing slope of many Drumlins bordering Lake Ontario are steep to precipitous, as wave action is very vigorous and is cutting away the material. At the close, or rather as the ice front was receding to the north, during the ice period, water stood to the south of the ice front forming lakes of considerable area. It is very evident of the work of water by assortment and deposition of bars and terraces around some of the Drumlins. While the waters from the melting ice was impounded to the south of the ice front, wave action was going on and was cutting

away material from the north facing slopes, similar to the work going on at present along Lake Ontario. In the vicinity of Red Creek in Northern Cayuga County, New York, many of the Drumlins are especially steep on the north facing slopes. This occurs at or near the level of ancient Lake Iroquois, which stood at a level of about 440 feet above sea level. The soil material at the foot of the slopes in this vicinity consists largely of stratified gravels and sands, showing assortment by water. This assorted material occupies bars or terraces which are smooth to gently sloping, and gives way on the south to abrupt to steep north facing slopes of the Drumlin ridges or hills. Stratified gravels and sands are present in many cases along the sides of the Drumlin hills and especially at the southern ends of the Drumlins. While the assorted materials were being reworked by the action of water, the typical Drumlin ridge stood out of the water as isolated hills or islands. Wave action was more vigorous on the northern ends of the hills than on the sides or southern ends.

Some of the Drumlin hills or ridges do not show the marked steeper slopes of the north face, however the larger part of them do.

The general elevation of the Drumlin belt of southeastern Wisconsin varies from 600 to 1100 feet above sea level, the average being 700 to 800 feet. The elevation of the Drumlin belt of New York ranges from 300 to 800 feet, the average being from 450 to 550 feet.

Parent Material from which the Soil is Derived.

Mr. Alden in his report of the Lithologic composition of the Drumlinsin southeastern Wisconsin says, "Estimates based on pebbles collected from drift composing Drumlins show that about 91 per cent of the coarser material is of local derivation". He also states "That if the finer material comprising the matrix of the till, the percentage of local material present might be found to be even larger". In New York, the kinds of gravel and stones present in the till section of the Drumlins, conforms largely to the geological formations over which the till mantle has been superimposed or the kind of rock the ice passed over before the till was finally deposited.

The typical Drumlin soils of New York are mapped as Ontario and Worth soil series with some little Honeoye soils, though the latter soil series is considered more of the ground moraine deposit. The principal geological formations underlying the Drumlin Belt of New York from Lake Ontario on the North, are Red and Gray sandstones and conglomerates, Grayish limestone, red and gray shales, with a limestone belt bordering the southern edge. The dip of the underlying rock is in general to the south and the formations passed over from the North to the South are from the older to the younger, geologically speaking.

In Wisconsin, the principal geological formations underlying the Drumlin Belt from Lake Winnebago on the north, to Madison on the southwest and Whitewater on the south, consists of Dolomitic limestone with layers of chert; blue and greenish clay shales with some thin layers of magnesian limestone; cherty Dolomitic limestone; blue and grayish magnesian limestone; light colored buff to reddish sandstone and magnesian limestone. This is in the order from the younger to the older formations.

The larger part of the Drumlin hills of New York are mapped as Ontario

soil series. This soil series comprises from 75 to 80 per cent of true Drumlin Hills. The kind of till from which the soil is derived is limestone, red sandstone, shale and some little crystalline rocks, in the order named of importance. The underlying limestone, though rarely ever exposed, has been very important in the formation of this soil series. The sandstone, which lies to the north, over which the ice passed has also had considerable effect, which is noticeable by the gritty or sandy nature of the soil. In a few places, the lower slopes have been influenced by outcrops of red and gray shales, imparting a reddish tinge to the soil. In places these outcrops of shale, give rise to the Lockport soil series. The parent material from which the Ontario soils are derived is largely of local debris, mainly of limestone and red sandstone. The crystalline rocks present have been transported a greater distance from the north by the ice.

The Ontario soils are characterized by brown to grayish-brown surface soil, light brown to brownish-yellow subsoils, underlain by brownish-gray to gray partially weathered till at 24 to 30 inches. The soil is mellow and friable, the upper subsoils is only slightly more compact than the surface, while the lower portion is more compact yet friable when dug or bored out. At 24 to 30 inches the soil and partially weathered till is calcareous. Scattered over the surface and through the 3 foot soil section is a considerable amount of gravels and stones, though these rarely ever interfere with cultivation. Surface and internal drainage is fair to good.

In a belt, along Lake Ontario, in northern Oswego, Cayuga and Wayne counties, lying to the north of the Ontario soils, is a strip of Drumlin soils mapped as the Worth series. The Worth soils differ mainly from the Ontario, in the kind of material from which the soil is derived. The Worth soils are derived largely from red sandstones, some shales and crystalline rocks. Only occasionally in the deeper portions is any limestone fragments present. The Worth Soils rarely ever show the presence of lime in the 3 foot soil section, though the deeper sections show some below this level. The Worth soils overlie sandstones and shales, though outcrops are seldom observed. A reddish to pinkish tinge of color is noticeable in cultivated fields, which is due largely to the weathering of the red sandstones.

Along the southern edge of the typical Drumlin belt, where the Drumlin hills or ridges merge into the true ground moraines, the soils are mapped as honeoye series. This soil series occurs in close association with the underlying limestone rocks, and outcrops are often present or lies a few feet below the surface. The soil of this series is darker colored than the Ontario series and has more compactness of material. There is an abundance of limestone till in the 3 foot section and the subsoil effervesces freely with diluted HCL at 12 to 15 inches below the surface. The topography of the Honeoye soils is gently sloping, rolling to undulating with intervening swales or slight depressions.

As a whole the typical Drumlin soils of New York are well drained, well oxidized to a depth of 20 to 30 inches and usually show considerable lime in the 3 foot soil section, especially in the lower subsoil or partially weathered till substratum. The parent material from which the soil has been derived is largely limestone and has not been transported any great distance as a whole.

The typical Drumlin soils of southeastern Wisconsin, are confined largely

to the Miami Soil Series; the intervening swales, depressions and terraces and less well drained areas being mapped as Peat and Muck, Plainfield, Clyde and Fox soil series. The Miami loam, fine sandy loam, silt loam and gravelly loam types predominate.

The Miami soil series is characterized by brownish-gray surface soils brownish-yellow to yellowish-brown and gray mottled in the subsurface and yellowish-brown, streaked with rusty iron stains in the subsoil. The subsoil is heavy and quite tough to a depth of 24 to 30 inches, where it gives way to partially weathered till which is calcareous when tested with acid. The Miami series is lighter in color, and heavier and more compact than the Ontario series. The parent material from which the soil is derived is mixed, consisting of limestone, sandstone, shale and crystalline rocks. The silt loam type is derived largely from limestone; the heavier soils from limestone and shale; while there is more sandstone and crystalline rocks in the lighter textured types.

The typical Drumlin hill or ridge soils of southeastern Wisconsin are well drained, though internal drainage is somewhat retarded by the compact and heavy nature of the subsurface. The soil material is derived largely of local debris, corresponding to the various formations over which the ice moved. The soils are calcareous in the lower subsoil or substratum.

Agricultural Value of Drumlin Soils.

While the topography of the Typical Drumlin ranges from gently sloping, undulating to comparatively steep or broken on some few slopes, the larger part is susceptible of intensive cultivation. The Drumlin soils of New York, represented by the Ontario, Worth and Honeoye soil series, are considered the most productive and highly prized farm lands of the State. These soils are farmed intensively to crops of Alfalfa, timothy and clover, wheat, oats, rye, corn, and potatoes. Truck farming is carried on in some localities and fruit raising is carried on extensively in a belt bordering on Lake Ontario. Crop yields are higher in this belt as compared to the "Hill Section" of the State, farther to the south, which is composed largely of Lordstown, Volusia and Canfield soils.

The Typical Drumlin soils of southeastern Wisconsin have been classified as belonging to the Miami series. In some counties as much as 30 to 35 per cent of the county is mapped as Miami silt loam, loam or gravelly loam. These soils are used for general farming, in conjunction with dairying. The Miami soils are considered quite productive and comprise some of the best lands of this section of the State.

Problems of Mapping Drumlins.

The true Drumlin Hill or Ridge is quite distinct in topography as compared to the typical ground moraine of the Glaciated section. The typical Drumlin invariably is characterized by a thick deposition of till, which has little or no stratification or assortment of material. At the close of the Ice Period, rounded gravels and sands were reworked and deposited by the action of water, building up terraces and bars at the north and south ends of the Drumlins and in places along the sides. This reworked or stratified material is not always present with each individual Drumlin Hill, however in field work, each Drumlin and the bordering slopes have to be studied and examined.

The mapping of the Drumlin Hill or Ridge does not offer the complexity of conditions as the more gentle slopes, terraces and intervening swales or depressions between the knobs or hillocks. The swales or depressions occurring between the Drumlin hills, varies from Peat and Muck through silt loams to clays. The subsoil or substratum varies from clays to layers of sands, silt and clay.

Drainage of the Hills or Knobs is good as a whole, while the flatter intervening tracts are usually in need of artificial drainage, due to the comparatively smooth topography and the compactness or heavy, impervious nature of the subsoil.

In New York, the following soils series occur in association with the Drumlin Hill soil, representing terraces, bars or lake laid materials; Fox, Tyler, Granby and Peat and Muck. In Wisconsin; Fox, Plainfield, Clyde and Peat and Muck. It is the problem of separating out the unassorted Drumlin till, in association with the reworked stratified terraces and bars and Lake Laid materials that are always present when one is mapping soils in the Drumlin Belt.

Conclusions.

First; Drumlin soils, as a whole are calcareous at 10 to 25 inches below the surface, the parent material being largely limestone. The surface soil in all probability contained lime, but owing to leaching, the calcareous layer has been carried down to a depth of 10 to 25 inches. Litmus paper tests of the surface soil, shows little or no acidity, usually being neutral.

Second; Drumlin soils, as a whole represent unassorted till material, which becomes grayer in color in the lower portion of the 3 foot section. In New York the material is usually friable with little or no compactness while in Wisconsin the material becomes heavier and more compact.

Third; The lower subsoil or substratum represents partially weathered till material and contains a higher content of gravels and stones, effervescing freely when tested with acid.

Fourth; Typical Drumlin soils have a pronounced topography, consisting of isolated hillocks or elongated narrow ridges with comparatively steep slopes, especially the north-facing slopes. The topography is much more pronounced than the more gently rolling to undulating topography of the ground Moraine.

Fifth; Drumlin soils, as a whole, are considered quite productive to a wide range of crops, and constitute some of the most valuable farming soils of the country.

THE SOIL TYPE AS A BASIS OF ESTABLISHING EXPERIMENTAL FIELDS.

By H. J. Snyder, Illinois.

The soil type in its broadest sense is generally accepted as the basis for establishing field experiments, or to state this in more practical terms, the experiment field is used as a basis for determining on a particular soil type certain requirements which may be necessary either to maintain or increase profitably and permanently its crop producing power. It does not necessarily follow that one experiment field on a single extensive soil type will answer this question. Soils of the same type often vary greatly in their response to treatment due to many factors, some of which may be such that they cannot be readily altered or controlled. There is in the field work conducted in this state, some very good examples of this particular point. One of our fields which is located on a soil type described as yellow-gray silt loam which was formerly timbered. The results secured on this field during the past twelve years show that there can be no successful cropping on this land without a liberal use of limestone, while the use of phosphorus so far has given only small and unprofitable gains. Another field located on the same soil type but in another locality has shown opposite results. Limestone is of no particular value on this field and the use of phosphate produced large and profitable gains. This is one example of several which might be cited indicating that field results obtained in one locality may differ from those obtained in another, although they both be located on the same soil type, according to the Illinois method of soil classification. This might tend to show that experiment field work at least in its earlier stages of development to be of the most practical value should be extensive rather than intensive. Field experiments also should be of long duration in order to determine if a continued treatment will in time overcome the differences in production found in various soil types, and within the same type. A soil survey to be of the most practical value must extend over a large area, and an extensive system of field experiments should go hand in hand with an extensive system of soil survey. One cannot develop its fullest possibilities without the other.

The University of Illinois in its soil investigational work has followed the plan of locating one or more experiment fields on each of the extensive soil types of the state. A plan similar to this is followed in many states, and particularly in Iowa, where a very extensive system of field experiments is being used in connection with an extensive system of soil survey. The field work in Illinois on various soil types was begun in 1901, and since that time there has been established over fifty experiment fields. At the present time there are in the state thirty-eight experiment fields, exclusive of the home station at Urbana. Thirty-four of these fields are devoted almost exclusively to soil fertility problems and represent ten distinct soil types.

Upon these various fields there has been used a definite system of soil treatment which includes the use of legumes, crop residues and animal manures to supply nitrogen and organic matter, ground limestone to correct acidity and supply calcium and magnesium, rock phosphate to supply phosphorus and kainit to supply potassium. This plan of soil treatment has been applied without variation to the various soil types of the state. The object has been to determine the influence of a simple and economical system of soil treatment found to be practical in its application under the prevailing farm conditions on the various soil types of the state.

Some of the experiment fields upon which this system of soil improvement is being used have been in operation for twenty years, while others have been operated a shorter space of time. The accumulation of data from these experiments is immense, and to discuss more than a general phase of this work is impossible at the present time.

The most outstanding development from these field experiments has been the practical use of crop residues as a source of nitrogen and organic matter. The most important part of the residue system has been the use of biennial sweet clover as a green manure crop which has been eminently successful on all types of soil. The residue system has been equally as successful as the manure system under similar conditions. In the following tables the residue system of soil treatment is used and in addition limestone, rock phosphate and potassium, this combination is commonly designated as a complete treatment.

In using the soil type as a basis for establishing experimental fields, or using the experimental field as a basis for establishing the requirements of a soil type, there may be secured results which are not representative if this work is too limited in scope. For example, the results of five northern Illinois Experiment fields all located on brown silt loam show that when the complete treatment is used the increase in wheat yield varies from 2 1/2 bushels up to 15 1/2 bushels per acre with an average increase of 8.1 bushels. Three experiment fields on brown silt loam in the central part of the state under the same treatment show a variation in wheat yield from 8.8 bushels up to 14 bushels per acre with an average of 10.8 bushels. On the gray silt loam on tight clay soils of the south part of the state the variation in increased wheat yield for this treatment is from 12.4 bushels up to 19.2 bushels per acre with an average increase of 16.4 bushels. On the yellow-gray silt loam soils which were formerly timbered the increase in wheat yield for this treatment varies from 14.6 bushels up to 18.8 bushels with an average of 16.1 bushels increase which is very close to that of the gray silt loam.

Using the results from this single crop on these various soil types shows that there are variations in yield within the type and yet the average results of two groups on a similar soil type show that there is a correlation. The average increases are higher on the lighter soils while the total yield is about ten bushels less than the more fertile soils.

Increases in wheat yields on various soil types due to the treatment of residues, limestone, rock phosphate and kainit. Yields in bushels per acre.

Field	Gray Silt Loam Tight Clay	Yellow Gray Silt Formerly Timbored	Brown Silt Loam Northern Ill.	Brown Silt Loam Central Ill.
1	16.2	14.6	3.8	14.0
2	12.4	18.8	15.5	9.6
3	14.2	14.8	8.5	8.8
4	19.2		10.5	
5	17.9		2.5	
Average	16.4	16.1	8.1	10.8

Fields are represented as follows:

Gray Silt Loam on Tight Clay	1. Toledo, (8 yrs.) 2. Newton, (9 yrs.) 3. Oblong, (9 yrs.) 4. Ewing, (10 yrs.) 5. Odin (19 yrs.)
Yellow Gray Silt Loam	1. Enfield, (9 yrs.) 2. Raleigh, (10 yrs.) 3. Unionville, (11 yrs.)
Brown Silt Loam Northern Ill.	1. Kewanee, (7 yrs.) 2. Joliet, (8 yrs.) 3. Dixon, (9 yrs.) 4. Mt.Morris, (10 yrs.) 5. Aledo, (11 yrs.)
Brown Silt Loam Central Ill.	1. Urbana, (12 yrs.) 2. Carthage, (10 yrs.) 3. Clayton (10 yrs.)

The number of years after the name of each field designate the number of years averaged for each field.

Discussion.

Discussion of Address -"The Soil Type as a Basis for Establishing Experimental Fields." - H.J.Snyder.

Dr. Brown -

"As far as our experiments in Iowa go, we have a number of years of data behind us for drawing average conclusions. At the present time we have about 75 experiment fields in different parts of the state and we are accumulating data all the time, getting comparisons of the effects of treatments in different counties in different sections of the state. They haven't been going long enough so that we feel like making any very definite comparisons on the effects of treatment. We are testing the use of much the same materials except that we are using in addition to the phosphate, commercial fertilizers for comparative purposes, and we find that we can check pretty closely with the results that Mr. Snyder has mentioned. The increased yields are of course larger on the lighter colored soils, and we get enormous increases in our light colored soils from the application of manure and from the application of phosphorus. The color of the soil and the need for organic matter does not bear any direct relation to the need for phosphorus. There are variations within the types that we find in our fields that are quite as noticeable as have been called to your attention here. We have an interesting problem as to why these variations occur in soils that are very uniform, very similar in plant-food content, very similar in every way, and still when we come to actual applications, we get these variations in crop yields. The only way to get at a definite conclusion is to take crop yields and to take them for a long period of time and get averages."

Prof. Wiancko -

"We have two fields on Claremont silt loam and the results are very consistent in the two fields. The farm at Lafayette and the Huntington field are very similar in the general character of the soil and the response to treatment seems to be very similar. Those are the only two cases where we have more than one field on the same soil type."

UTILIZATION OF SOIL SURVEYS.

By Chas.F.Shaw, Professor of Soil Technology, University of California.

The value of the soil survey depends on the extent to which it can be used by the people. As a historical document--an inventory of soil resources and conditions--to be filed away in libraries, it has little justification; the basic reason for supporting the work is the anticipation that the survey will have a definite utilitarian value--will be of positive use in solving the problems of today.

The Farmer -

The first and most obvious use of this soil data is by the farmer who is already located on the land, producing crops from the soils of his own farm. The use by farmers is not as general nor the results as satisfactory as we could hope. This is due to two major reasons--first, the farmer does not know how to interpret the soil surveys; and second, the scale on which the maps are made does not show the many variations in soil conditions which he knows exist on his farm. The first of these difficulties will gradually disappear provided we teach, in school and college, in short courses, in farmers' meetings, and elsewhere, the possibilities of the survey and the ways of interpreting its results. The second will always be before us, but with a better conception of soil classification and soil differences the farmer can more readily understand the limitations of the soil maps and the import of those minor variations on his own farm. The use of the soil maps by the land holding farmer will never, in my opinion, be the major use of our soil survey data.

The Land Seeker -

The surveys are of much more direct value to the land seeker, the man who is purchasing a farm, the new settler who is not familiar with the soils of the region and who needs and desires unbiased and honest information regarding the farm lands that are offered to him. In those sections of the country where new lands are still available, the soil maps are almost indispensable and will give the desired information provided the user can interpret its data, or provided he comes to the soils departments for assistance and advice in using the maps.

While the use of the survey by these people is not as general as we could wish, it is growing rapidly, as a study of the files of any Soils office will show. We can promote this use by suitable publicity, both through our bulletins and the rural press, and by our instruction, particularly during short courses. In California, we last year gave short courses in Land Settlement and for New Settlers and this year will give another in Land Colonization. In each of these courses much time is devoted to discussions of the soil, soil surveys and the use of the available data. As these short courses are attended by both the land seeker and the land seller (the realtors and colonization agents) the effectiveness of the information is much increased.

The County Agent -

The use of the soil surveys by the county agents is constantly increasing

but here again is much need for education. Many of the agents do not yet understand either the possibilities or the limitations of the surveys. We can be of material aid in helping them use the maps in planning county activities, the location of demonstration tracts, etc., but primarily we must aid them to so understand the soils of their county and interpret the soil data of map and report, that they can solve those very definite, local problems that continually face them in their work. This can be done only by personal work in the field with these men, and calls for tact and a sympathetic understanding on the part of the soil survey man. Occasionally a lack of sympathy, or perhaps actual hostility on the part of the Agents themselves or the state leaders may make our task much more difficult.

Federal Land Bank.

A very direct use of the soil surveys is that by banks, trust companies and insurance companies who loan money on land. You are all familiar with this use but I wish to call attention to a specific instance showing the way in which our data is being used. The Federal Land Bank of Berkeley has loaned me one of their township plats bearing characteristic data. On this they have copied by the usual method of colors, the soil types that are shown on our smaller scale map. The location of marsh areas, of alkali spots and other soil data is shown, and irrigation or drainage district boundaries and similar information that would influence the value of their loans, are plotted. The tracts representing the loans are platted, and the appraisals are to a considerable extent based on the basic soil information given by our maps. Each appraiser and engineer is supplied with the local soil map, mounted on cloth in sections so it can be folded and handled without tearing, and these are used constantly. The central office, with full description of each soil type, and a constantly accumulating amount of information bearing on its use and value, checks the findings of the appraisers against this basic data. The reports of the appraisers frequently carry acknowledgments of the aid of the soil surveys and a pleasing comment on the general accuracy of our work is the rare occasions when the appraiser or engineer (usually with much glee) can report findings that disagree with our maps. The officers of the Bank keep closely in touch with our soil survey work, frequently securing data in advance of the final publication, and they freely acknowledge the value of our surveys in aiding the work of their institution.

State Officers.

The State Engineering Department, the State Bonding Commission, the State Land Settlement Board, and other State officers and institutions are using the soil surveys in a constantly increasing degree. On the Engineering Department and Bonding Commission falls the responsibility for the authorization of the establishment and financing of Irrigation, Reclamation and Drainage districts. As the success of these districts depends on the soils, it is gratifying to note that our soil surveys are taken as the basis for inclusion of lands within or their elimination from the proposed districts and for determining the financial load which the districts can assume. In cases where this data is not conclusive, members of our force are called upon to give added information, or to aid in judging the relative values of the soils in order to arrive at a fair decision. The extent and location of the Irrigation Districts are usually determined by the soil conditions, and in some instances the decision regarding the portion of a county or a region which will receive a coveted water supply has been determined wholly by the information made available

through our soil surveys.

The Land Settlement Board.

The State Land Settlement Board has given our soil surveys the greatest recognition and in fact, depend wholly on our data for selection of the lands to be subdivided and for the evaluation of the farms that are sold in the colony. The Division of Soil Technology examined and reported upon each of the 104 tracts, totalling 714,636 acres, that were offered to the Board. For the first Colony--one of the three sites that we recommended was chosen--the site at Durham, while the site of second colony, at Delhi, was also one of the three that we recommended as best suited. Of the 104 tracts offered, we considered only 16, totalling 89,088 acres, to be of good quality and most suitable for colonization.

The most interesting and valuable work was done after the site of the colony was purchased. We made a detailed soil survey, on a large scale, showing not only the regular soil types, but also all the phases that might modify the crop yields or cultural methods. When these maps were completed, we set basic values on the various soil types and phases, then measured the acreage of each and calculated the total value or the gross selling price of the whole colony. This sum included the original purchase price plus all expenses of subdivision including examinations, surveys, overhead, estimated costs of selling the land, supervision for the period of amortization, etc. Having found that the total amount of these values was sufficient to yield the desired sum, we proceeded to evaluate the individual farms. The area of each kind of soil on the farm was measured, multiplied by the acre valuation and the amounts thus obtained added and divided by the number of acres in the farm. The selling price per acre of the farm does not represent the value of any one type of soil but the average value of all the soils making up the farm.

The variability of the soil (modified or exaggerated to some extent by variations in selling price due to equalization for location, accessibility, etc.) is shown by the graph, on which the height of the heavy line indicates the per acre value, and the length of that line the number of farms sold at any one acre-price. The more variable soils at Durham are shown by the more irregular line, while the smoother Delhi line reflects the influence of the more uniform soil conditions.

In these colonies the lands were sold at their actual value, as determined by the best available experts, and the results have been most gratifying. Every tract has been sold at Durham and of the 139 owners (including farm laborers on two acre allotments) only 13 have sold their farms and only 8 left the colony. On the Delhi tract, the fourth unit is now being sold, 216 families being already located on lands sold during the last two years, and of these 216 farms, only 17 have had any change in ownership.

We feel that this enviable record is due, in considerable measure, to the method of evaluating the farms. At Durham the selling price varied from $325.00 to $25.00 per acre, there being 42 different values. Two adjacent plots, separated only by a fence sold for $77 and $200 per acre, yet each purchaser is satisfied with his purchase and convinced that he secured his farm at a fair price. No settler has complained about either the actual or relative price of the ranch he purchased--that the ranch was too high on the basis of its producing value, or as compared with other farms in the colony.

Furthermore, we have no unsold farms, we have sold all the land in the original purchase, and our future activities are confined to the necessary supervision and collections of the payments as they fall due. We have had no auctions or bargain sales of the less desirable tracts--the method of evaluation made them all equally attractive. We feel proud of this record and feel that it is a tremendously valuable demonstration of the use of the soil survey. We feel confident that the private colonization enterprises will soon come to a more or less similar method in offering their farms to the public, and a great extension of the use of the soil surveys and soil survey methods will result.

We could report many other ways in which our soil survey data is being used--by county assessors, land appraisers and commercial institutions, by experiment station or department investigators, by teachers in schools and colleges, all of these being more or less familiar to you all. In California we have "sold" the soil survey to the State Land Settlement Board, the Federal Land Bank, and other important institutions. We feel that our work has just begun and that the possibilities of our usefulness are still to be developed. The soil survey is fundamentally basic data and will ultimately be the foundation upon which scientific research and commercial development of our lands will be established.

DESCRIPTION OF FIELD METHODS FOLLOWED BY THE MICHIGAN LAND AND ECONOMIC SURVEY

By L. R. Schoenmann, Chief Soils Division.

Michigan's problems of conservation, development, and agricultural improvement have a broad similarity to those of her neighbors, Wisconsin and Minnesota. Our annually increasing acreage of cutover land; the steadily decreasing area of productive forest; the State's attractiveness and accessibility to tourists and recreation seekers, coupled with the necessity for conserving the fish, game, and wild life for maintaining this attractiveness; the variety and importance of the mineral resources; the insistent call of our fast growing manufacturing centers for power, raw material, and products of the farm, have forced upon those interested in the State's growth and development a realization of the keen necessity for formulating intelligent and constructive policies to guide the use, development, and conservation of the idle lands, the forests and other natural resources.

On the other hand, due to local conditions, Michigan's problems have an individuality which calls for local study and local application. Policies cut on the wide spreading "Mother Hubbard" style which cover everything and touch nothing will not fit the situation. What is required are policies based on facts as obtained from two localized sources of information:

First, an inventory by counties or regional units of the present status of the State's resources and the industries arising out of, and dependent upon their development and use; and second, a study of the economic conditions and factors which are accountable for their present existing state of use or lack of use. Such an inventory and study will reveal that certain regions of the State have problems peculiar to themselves; and that these can only be successfully handled when recognized as local.

The Land-Economic Survey was organized to make this inventory and study. With that as its object it is necessary for the survey to be broad in its scope and to bring into cooperation all the forces and organizations capable of giving assistance. A study and classification of the soil element is a vital and important branch of such a survey. In some instances it will have a dominant influence in shaping the policies of development, conservation, improvement, or reconstruction. In other instances it may possibly be only a contributing factor which is overshadowed by the importance of some other single factor or group of factors.

Accordingly then, in April 1922 a cooperative agreement was made between the State Department of Agriculture, State Conservation Commission, Michigan Agricultural College, University of Michigan, and the United States Geological Survey for the pooling of men and money to carry out the past season's field operations. The Advisory Committee representing the cooperating organizations voted that the interests of the cooperating bodies in the Survey should be focused on the field operations through a Director the State Geologist, Mr. R. A. Smith, in charge of a field organization, consisting of a Field Manager, with a Chief of Forestry and a Chief of Soils, each of whom had an experienced assistant or captain and eight field men. These field men were inexperienced but consisted of Juniors, Seniors, and Graduate students from the University of Michigan, Michigan Agricultural College, University of Wisconsin, and the

University of Chicago, all of whom had had special training either in Forestry, Soils, Geology, or Geography. In addition to this regular organization which was maintained throughout the season, we had the services and help in the field for varying periods, of unattached special workers, such as Mr. Frank Leverett, in surface geology; Dr. Dachnowski in peat investigation; Dr. Bessey, Dr. Harvey, and Dr. Darlington in botanical lines; Dr. Sauer in economic geography, who gathered detailed data on tax conditions, land occupation and ownership, besides making an historical study of the economic situations which have attended and influenced the agricultural and industrial development. Prof. Wisler investigated the water power and drainage, and Miss Martin the water supplies. These related lines of work took into account the source, character, and adequacy of municipal water supplies for industrial and domestic use, the establishing of gauging stations on those streams having developed and undeveloped water power, careful leveling to determine the fall throughout their course, and a detailed study of all existing and promising sites for power development. The work of the State Biological Survey under Dr. A. G. Ruthven's direction was centered largely on the area covered by the Land Economic Survey and made a contribution to it.

Charlevoix County was chosen for the first season's operations because it seemed to offer a diversity of interests and conditions which would give probably a broader opportunity for working out field methods than any other county in the State. The field work was carried on from two headquarters camps, which were also used as a base by the special workers. These camp sites were moved at intervals of about ten to fourteen days. The geographical conditions, roads, and water supply for camp use in a large measure determined the location of camp sites, but the aim was to work an area of at least a township from each camp site, established as near the center of that township as possible. As much as possible the two camps were kept in adjoining townships in order to facilitate visits between the camps by the Field Manager and Division Chiefs.

Each camp had six sleeping tents, one 10x12 office tent, and a 16x16 cook tent. Meals were prepared on army field ranges by efficient by tempermental cooks. During the summer the work was scheduled on central time, and during the fall on Eastern time. The order of the Day was:

"Roll out"	6.00	A.M.
"Cakes"	6.30	"
Start for field	7.15	"
In camp	5.30	P.M.
Supper	6.00	"
"Pipe Down"	10.00	"

The first field party arrived in the county June 23, the second July 6. The day of arrival in each case was consumed in establishing camp. The next day property, equipment and instructions for mapping and description were issued to the field assistants, and a sort of school of instruction held. On the following day the assistants were taken out in a body for general field instruction, and on the third day the forestry and soils assistants were divided into separate groups and given more technical field instructions. Then the field assistants were assigned into pairs, one soils man and one forester to each pair, and actual field mapping undertaken.

In the settled regions territory was assigned to each pair of assistants

by sections, mainly, and in the unsettled regions by strips. The mapping was based on and tied in at known section and quarter corners or carefully run control lines, except on some of the smaller islands of the area where a shore traverse with offsets was used to some extent. The standard interval between lines was one-half mile. The forester acted as compassman and kept the tally, the soils man depending on the forester for his location and distances.

During the first part of the season an hour or two was spent nearly every evening in a sort of conference or round table discussion of the local field conditions encountered during the day's work and the application of the instructions and classification interpretted. The forestry assistants did not have to stand for as much of this sort of thing as the soils assistants, chiefly, I think, because the forestry schools stress field work more strongly than is common in soils courses. During the first part of the season the Division Chiefs accompanied a different pair of field assistants each day and demonstrated the methods of classification, mapping, and description. As the men gained experience the necessity for this work lessened and the chiefs were able to spend some time on special work, on checking over and revising the early work, and in scouting ahead of the field men.

Two complete maps were made in the field, each on the scale of eight inches to the mile. The one made by the foresters was called the Condition Map. It is the base map for the published maps and shows such cultural features as:

1. Steam and electric railroads.
2. Power, telegraph, and telephone lines.
3. Highways classified into second class, first class, gravel, and hard surface.
4. Houses, occupied and vacant.
5. Summer cottages and resort hotels.
6. Schools, churches, town halls, Grange Halls.
7. Springs, streams, and lakes.
8. Dams and bridges.
9. Wells - dug, driven, drilled, and artesian.
10. Logging camps.
11. Sawmills, permanent and portable.

and a land utilization classification of

Red (A) Improved farm land
   1. Crop land
   2. Permanent pasture
   3. Orchards
   4. Used stump land

White (B) Idle land
   1. Abandoned farm land
   2. Unused brush land
   3. Unused stump land
   4. Pin cherry and aspen areas
   5. Recent cutover and shashing
   6. Recent burns
   7. Beach and bare dune areas

Green (C) Upland Timber Areas
1. Non-merchantable second growth)
2. Merchantable second growth) Predominant species named.
3. Virgin timber)

Yellow under green (D) All timbered swamp lands.

Yellow (E) Open grass and sedge and brush swamps.

The soil map carries the mineral resources, the soil and surface classification, and only such of the cultural features as were considered necessary to assist in mapping the soils and surface features. On the field sheets colors were used in the mapping of surface conditions:

I.	Level land	Uncolored
II.	Undulating	Yellow
III.	Slight slopes on terraces	Yellow lines
IV.	" " " upland	Yellow lines on solid brown
V.	Moderate " " "	Solid brown
VI.	Steep slopes	Solid green
VII.	Hilly, rough, & Broken areas	Red
VIII.	Eroded spots on any slope	Deep red

The soil types were left uncolored on the field sheet, but were limited by a soil boundary and designated by number. The mineral resources were limited by a special boundary and designated by symbol, for gravel, shale, clay, marl, etc.

A tally sheet was filled out for each quarter section, which covered detailed data and information which was for the most part not readily mappable. The data relating to agriculture, non-agricultural residents, and effect of predatory animals was obtained by direct interview, and that pertaining to (1) surface, (2) soils, (3) water bodies and streams, (4) mineral resources, (5) wild life, (6) peat, and (7) vegetation, was obtained by observation.

The recognition of soil units or types is based on the zonation of the soil material, i.e. the number, thickness, and position of zones or horizons exhibiting differences in color, texture, and structure, normally within a depth of 36", and of the natural drainage conditions.

CLASSIFICATION OUTLINE

Origin	Division	Symbol	Physiographic Group
Residual	Crystalline	R#	Upland
	Limestone	R*	
	Shale	R=	
	Sandstone	R'	
AEolian	Dunes	D	
Glacial	Morainic till	M	
	Morainic border	MB	
	Till Plain	T	
Fluvio-Glacial	Kame	K	
	Esker	E	
	Outwash	O	Terrace
Lacustrine & Littoral	Lake shore	S	
	Lake bed	L	
Colluvial & Alluvial	Valley Fill	F	
	Stream terrace	T	
	" bottom	A	Lowland
Cumulose	Marsh border	B	
	Muck	Mu	
	Peat	P	

NOTE: The symbols (#, *, =, ') used to differentiate between the parent material of the residual soils are usable to indicate the dominant lithological characteristic of the soil of the other divisions as well.

In naming these soil units the word "on" is used when the most prominent and important change in the character of the soil material occurs above thirty inches in depth, and the word "over" is used when this change in the character of the soil material occurs below a depth of thirty inches, as for instance "Brown sandy loam on red sandy clay", or "Black loam on gray sand over gray clay".

On the published map the limits of the individual soil units will be shown by soil boundary and their identity retained by the Key symbol, which will indicate their textural character, the mode of origin of the parent material and its dominant lithological character, where this is apparent. For instance, a brown sandy loam underlain at a depth of less than thirty inches by a reddish sandy clay subsoil will be given the soil unit name "Brown sandy loam or red sandy clay." Where the origin of the parent material is glacial and the soil material is derived from terminal morainic drift which contains a high percent of limestone material, then if the soil exhibits a strongly calcareous character it will be designated by the key symbol M*sl on the published map. This key symbol will appear on the soil map legend and preceding the soil unit name at the heading of the soil unit description in the report. If the parent

material were terminal morainic drift chiefly from crystalline rocks the symbol used would be M#sl. If from sandstone M'sl. Where the material is heterogeneous in character and exhibits no dominant lithological character the key symbol would be Msl. Again, a residual soil derived from shale would have the key symbol R=si, if it were a silt loam texturally.

On the published map the surface condition classification will be represented by a system of simple cross hachuring in brown, color being used to represent a grouping of the soil units according to their textural or other dominant characteristics.

I.	Gravelly soils	Red
II.	Sandy soils	Yellow
III.	Sandy loams & loams	Light brown
IV.	Silt loams & clay loams	Deep brown
V.	Clays	Purple
VI.	Marsh border soils	Light green
VII.	Muck and peat	Deep green

For the peat materials the field map symbols used indicated character, origin, depth, and mineral subsoil.

Origin and character.

Forest peat - F - Woody
Sedge peat - S - Fibrous
Aquatic peat (A - Macerated
(C - Colloidal

Moss Peat (To be added when found
Heath Peat

	Depth	
(Type No.)	14	Over 8" deep and less than 18" deep
	14-	" 18" " " " " 36" "
	14+	" 36" "

Mineral Subsoil		
14	S	means peat less than 18" deep on sand
14-	S	" " " " 36" " " "
14-	C	" " " " 36" " " clay
14-		" " " " 36" " " marl.

The limit of each peat deposit is indicated by a soil boundary, but no definite boundaries are drawn within a single deposit. Instead the conditions encountered at the point where the deposit was sounded are indicated by symbol, as F14-s, is Forest Debris over 18" deep but less than 36" deep having a mineral subsoil of sand. S14+c, for sedge peat over 36" deep having a clay subsoil. $\frac{S^2}{A}$14+ , for two feet of sedge peat on macerated organic material over a mineral subsoil of marl encountered at a greater depth than 36". Deposits of any important extent, which the field assistants found to be deeper than the 42" soil auger, were visited and sounded with a Davis Peat Sampler, the data being recorded on a special Peat investigation form:

The classification of surface vegetation on swamp areas shown in color and symbol on the condition map for the peat and muck deposits consisted of:

Swamp	Color green on map
D	Maple, ash, elm,
C	Tamarack, cedar, balsam,
Sh	Willow, alder, aspen, dogwood, (R.O.)
Bog	Color brown on map
S-C	Sphagnum, cranberry
H	Laborador tea, pale laurel, leather leaf, blueberry.
Marsh	Color yellow on map
R	Reeds and canes
B	Blue joint
W	Wire grass
S	Saw grass
Aquatic	Color blue on maps all shallow lakes and ponds with a soft muddy bottom of muck material.

It is regretted that Dr. Dachnowski did not have the opportunity to outline his methods until after the season was rather well advanced. As a result the classification of the peat materials is not as fully carried out in this first area as it will be in the future work. Dr. C. S. Robinson of the Michigan Agricultural Experiment Station is making a chemical investigation of the peat materials which will be covered by a separate report. The chemical analysis of the samples gathered to represent the mineral soils is also being made by the Experiment Station Laboratory.

In this outline of the Field Methods followed on the Land-Economic Survey, I realize that the work assigned to the regular field assistants in the divisions of soils and forestry has been presented in much greater detail than those branches of investigation which were assigned to the unattached special workers. This seemingly intentional slight is due solely to my lack of familiarity with the detail of their methods. Their work is as valuable and vital to the Survey as that of the regular organization. In fact Act 373 Public Acts of 1917 under which authority for the Michigan Land-Economic Survey is established, expressly empowers their cooperation, and by this means an investigation and study of the climatic conditions, the forest conditions, the soil, land occupation, ownership and utilization; tax conditions; the distribution of fish, game, and wild life, with the conditions for its propagation and conservation; the recreation opportunity; the water and water power resources; the mineral resources; and the economic conditions and forces influencing the present and future agricultural and industrial development, is coordinated into a survey which is more than an inventory of the soil and agricultural conditions, and justifies the name Land-Economic Survey.

Discussion.

Discussion of Address - "Description of Field Methods
Followed by the Michigan Land and Economic Survey." - L. R. Schoenmann

Mr. Wright -

"Has that scale, 8 inches to the mile, been used satisfactorily?"

Mr. Schoenmann -

"So far as its being satisfactory is concerned, it was highly satisfactory, but we now expect to decide definitely whether we will continue with the 8 inches to the mile or whether we will reduce it. It has some advantages. We have felt that we must have something large enough to use in the field so that we can show detail which we don't want to show on the published map, because we have requests that come in after the map is published, which we can answer only from a map on a large scale. We are going to work on a large scale and experience will tell us what that scale should be, but when we publish these maps a lot of the detail will not be indicated, but we will have on file in our office the detail so that we can give out information. One other point, in the training of new men, a small scale is a hard thing for a man to accommodate himself to, and he is going to have trouble with it, so it is easier to have new men work with a large scale."

Dr. Alway -

"What was the cost of this survey?"

Mr. Smith -

"Yesterday I made some computations as to cost. Being a very complex survey, of course the accounting is very much involved as well. We have definitely worked out that the soils work has cost 2.9 cents per acre. At the present time its cost is 7.3 cents per acre for the whole map. But the costs are too high. This is a new thing. We have never done anything like this before. We had to go into this thing after April 10. At that late date you can imagine how many good men there were. We had to get an organization together in a hurry. Everything was high speed. Our efficiency was very much the same as when we started into the war. Next year we are going to avoid a lot of that, we are going to work this thing out. We have made a great many mistakes and we are going to correct some of these things and we hope we will get some suggestions here today.

"Now whether this particular kind of a survey is adapted to your needs will depend on your needs. This kind of a survey must be carried on in that part of Michigan which is 30 per cent undeveloped, and this does not affect the southern part of the state, which is well developed, but it does affect the northern part of the state. We find that Charlevoix county is falling down because it hasn't a proper agricultural or Horticultural Association. With the correction of those things the Farm Bureau, College of Agriculture, and farming industry can help. Land sharks have been active in Michigan. In this land economic survey we are groping to find a solution of our problem, particularly for the northern part of the state."

Dr. Condra -

"- - - - -

I wish you would pass a resolution in favor of a topographic survey in our country, because it is so very much needed, the most fundamental thing. The soil survey isn't the whole thing. It doesn't exist for us alone. Let's see that we work together harmoniously."

Mr. Smith -

"We only have about 22 per cent of the state mapped, and that has been a case of necessity. We don't defend many of these things. We have been doing the thing that we thought was best under the conditions. Now as to the matter of reports. The details are not all going into one report, but this work will form the basis of a large number of reports. We are in danger of getting our reports too popular. We will have to watch very carefully so that our reports are not kindergarten material, so that they will be of interest both to the layman and to the trained man, so that they will be a happy medium."

THE SOIL SURVEY - PRESENT & FUTURE

By P. S. Lovejoy

(Read by Dr. F. J. Alway)

One point of view regards soil surveys as primarily intended to do for soils what Gray, for instance, did for our native plants and what the Geological Survey is doing for topography. From this standpoint the chief function of any general survey is to discover, describe, identify, catalog and map the specific entities of its particular field. Gray's manual lists and keys the plants, Sargent lists and keys the trees, Dana listed and keyed the minerals. Biological and ecological surveys check the manuals of the botanist and zoologist, recording ranges and habitats where the earlier surveys merely determined occurrences. The glacial geologist supplements the work of the structural geologist and the paleontologists fill in the gap between the biologists and the geologists; all of them conducting "surveys".

In the typical case, whether in botany, geology or soils, the surveyor is first concerned with the purely scientific aspects of the work. Gray and Sargent did their work and left it to agrostologist, agronomist and forester to find uses for their lists and keys. Dana explains how to identify the minerals but does not concern himself with mining. The topographic surveyor runs in his contours but does not care whether the gradients he shows will favor or prohibit railroad construction.

So, from one standpoint, the soil surveyor does not concern himself with the utilities, or possible utilities, or potential utilities, of the soil types and conditions which he maps, but proceeds to identify describe and analyze whatever he happens to find, leaving it to others to find specific utilities for the maps, reports and analyses.

By all good precedent this proceedure is wholly justified and correct. A proper and adequate general soil survey should be scientific, uniform and complete. Unless soil surveying makes an exception to other sciences, it should be conducted by specialists who are not overly, if at all, concerned with "practical" phases of soil utilities. And it is hardly for outsiders to protest too much at whatever of names and legends the professional soil surveyors may see fit to use: like the other groups they are entitled to any nomenclature which suits them--it will at least be better than that of the entomologists and pathologists.

It is often alleged that this is the sort of a soil survey desired and attempted by official Washington but not the sort of survey desired and attempted by the majority of state field workers. Right here, I think, develops a friction and confusion, for the soil survey has been "sold" to the public on specifications quite other than those of "pure science".

There are many very pressing soil problems; there are many men paid to work out the solutions to these problems; very naturally such men desire and expect soil surveys to be of definite assistance in their applied work. But the majority of our soil survey workers seem to be both teachers and surveyors, experimenters in the scientific and in the applied phases. Under such circumstances a confusion would be inevitable. This confusion between the "scientific"

and "practical" points of view threatens to get soil surveys "in wrong" with the public; indeed I think that has been accomplished already--if my own experiences and correspondence are criteria.

"Of such little practical importance that I don't bother with them", a southern experiment station man told me.

"I don't take much stock in soil surveys" writes a northern real estate man. "In the first place they don't tell the full truth about conditions. They cost more than they are worth. They don't dare tell the truth anyway". Continually I have inquired of official and private land development organizations and of farmers, whether and how they used soil surveys. With few exceptions they evade the question or openly sneer.

The great exception, no doubt, is Wisconsin. Here the surveys are in constant and important use: but not in their original form. And in Wisconsin progressive farmers are urged to take advantage of a special surveying service which gives them almost a field-to-field report and map. Those special farm surveys, however, seem to be based more upon farm management than upon the detail of soil classification or analysis.

This, I take it, is wholly normal. But such developments and practices seem to contradict the official dicta of the American Association of Soil Survey Workers. The origin, nature and significance of those contradictions, I think, require canvassing.

Several items, it seems to me, require frank discussion. The first is the matter of the two points of view already mentioned: Is and should the soil survey be primarily scientific and considered as a job in taxonomy, or is its chief function to discuss and report upon the actual and potential utilities of given soil types and land areas? If both, to what extent may the two functions be properly combined?

It seems very clear, to me, that the primary soil survey should be kept very definitely scientific and that it should concentrate upon those soil factors which are relatively fixed and unchanging. This, of course, involves the regular order: identification, classification, mapping, physical and chemical characteristics. The primary survey should not attempt to deal with the temporary and mutable factors respecting soil uses, save as it uses or reports upon original growth or current conditions as a check or elaboration upon the auger, sieves and test-tube, or save as it makes notes of existing land uses or conditions the historical record of which may otherwise be lost. Is this the theory of official Washington?

The question now passes to the other item: To what extent and under what conditions may specific utilitarian problems of land utilization be combined with the purely scientific work of soil surveying?

Here I should like to raise an issue and to compare the allegations and promises of the Association's Bulletin 2, with the facts as I see them.

Says the Bulletin: "Such a survey classifies agricultural and nonagricultural land, divides the soils which are adapted for general farming from those which are suited for various specialized crops, gives an idea of relative

land values, classifies lands suitable for forestry purposes, and indicates wet and dry lands capable of reclamation".

It is further alleged that the reports accompanying soil surveys will incorporate the latest experiment station data as to fertilizers and soil management, will be of value to the settler, to road engineers and manufacturers, teachers and county agents, experiment stations and in public health control.

It alleges that such a survey can be conducted at a cost of three cents an acre.

Now I submit that no soil survey ever did or ever actually could accomplish a decent measure of all those utilities, or for three cents an acre. And I must insist that the bulletin nicely illustrates the confusion and divergence of view-points already mentioned. In sober fact, the Bulletin is not discussing or advocating a soil survey at all and the survey which it purports to describe could not properly be called a soil survey. Any sort of a survey which is inadequately made is bound to prove irritating, a nusiance, or an actual menace. Perhaps a proof of this may be found in the fact that existing "soil surveys" are often "in wrong" with the very people whom they profess to assist.

I agree most enthusiastically that some sort of a survey, which will in fact accomplish the things promised--and many others--is most urgently needed. I assume as a matter of course that the scientific soil survey is fundamental and that soil surveyors must play an important part in the conduct of that sort of a survey which is needed. But I must protest very loudly that Bulletin 2 (and soil surveyors in general) has badly confused several different functions and that it promises things which no soil survey and no soil surveyors may hope to deliver. They have undertaken too much: failing to deliver according to their own specifications they have gotten themselves and their work "in wrong".

Note how the Bulletin interchanges "soil" and "land"--as though they were practically synonomous! It says: "it is doubtful whether any other line of public work is of such great "economic" value . . ". In those statements, I think, the core of the whole difficulty is exposed.

Beginning as an expert in soils, their identification, classification and mapping, now the soil surveyor is offering himself as an expert in land utilization and, as a land economist--all in the same breath!

Note also how little the Bulletin dwells upon the scientific aspects of the soil survey, as described and promised. Is the significance of that that the surveyor is here bidding for public sympathy and support? In part, no doubt. But who may question but that the soil surveyor is also inclined to regard himself as really quite competent to pass upon affairs of land economics and utilization? There are many other soil surveyor's bulletins and they read much alike.

Since nobody else was offering to render such services, and since such services were certainly badly needed, the soil surveyor is rather to be praised than blamed for having jumped in. But jumping in and swimming out are

quite different matters. And, instead of remaining on technique and production, suddenly the accent of agricultural affairs has changed to marketing and economics. In effect, the water rose suddenly after the soil surveyor jumped in.

In any case, here is the soil surveyor offering himself as a competent expert in the "classification" of agricultural and non-agricultural land, as an appraiser of lands for grazing, general farming and special crops. He undertakes to "classify" lands for "forestry purposes". He offers to identify wet and dry lands "capable of reclamation". He will make his maps show the items of importance in economic geology. He will include a chapter on sanitation . . . and conduct a second-hand course in farm-management . . .

And on the basis of what sort of special training will the soil surveyor do all this? I urge that the curricula out of which soil surveyors typically graduate be checked with circumspection. I submit that no school does or could undertake to train a man in such a category. The thing is utterly preposterous--if I may be wholly frank and speak my mind. For, in addition to whatever special training in soils and in surveying may be deemed necessary, the items listed lie in the special provinces of the technically trained agricultural economist, the grazing expert, the agronomist, the farm-management specialist, the forester, the economic geologist, the agricultural, civil and sanitary engineers, each one of them requiring years of special training and experience in order to become competent. And the list of items which ought to be included, and which must be included (if such a survey is to be truly adequate) should be extended. What, for instance, of the hydraulic engineer, and the economic biologist and the recreation engineer and the specialist in settlement and development?

The thing is obviously impossible: grown too big for any one man or small group to hope to handle. Done inexpertly, inadequately or incompetently, any survey becomes at least a nusiance; this sort of a survey becomes a menace not to be tolerated by anyone: "in wrong" because of that.

Here, I think, I should be somewhat specific, even at the risk of seeming rude. I know of no State the agricultural vision, policy or administration of which I admire as those of Wisconsin. Where Wisconsin fails, then, others will be failing.

Now do Wisconsin farmers use the survey to distinguish between their agricultural and non-agricultural lands? Of course not. Do prospective settlers use it? They do, but only to locate the major phases of the conditions in which they may be interested, and then only after elaborate urging and the putting of the maps into their hands. They may not trust those maps for local detail and, if for no other reason, because those maps fail to show or report upon many items wholly essential to competent or intelligent farm location: ownership, relative values, social conditions and costs of clearing, for instance. But no set of maps could well indicate such things? Then the Wisconsin survey has fallen down on one of its promised services. And I will question whether this survey has been even competent and candid as to the major phases:

"Portage County: 1918; Plainsfield sand: Original growth scrub (?) oak, red and some white oak, Jack-pine and sweet fern . . . The Jack-pine was most

common . . . Abandoned farms are not unusual . . . The yields of all crops are considerably less than on the heavier soils , . . The difficulty of maintaining good pasture and of growing enough hay for feed, prevents such development of dairying as is common on heavier soils . . . ".

Oh fie, and for shame! And Wisconsin with millions of acres of real dirt, lying idle and hungry for silos! I will further suggest that the inside story of Wisconsin's official and technical relations to peat lands are, as in a neighboring state, "a sorry tale", for peat must be regarded as "potentially" of value for agriculture, of course.

Do the soil surveys then classify agricultural from non-agricultural land? They do not. At most they hint and intimate, broadly and safely, in technical accuracy, no doubt, but in actual euphonisms.

Do the surveys "divide the grazing from the general farming and special crop lands?" In the old-settled districts the farmers hardly need and certainly do not use such soil surveyor's determinations. In the new and undeveloped areas the surveys do not even attempt to make such determinations save as they list or discuss marsh, sand, loams and clays, or as they mention rocks and hills--"rolling hills", usually, of course.

Do the surveys "classify lands suitable for forestry purposes?" Well, as to that, we have the Vilas County job, with the issue for the first time, definite and clear. As of its time and place, and considered in connection with its attendant circumstances, that was doubtless a bold and decent piece of work. But today, seven years afterward, while still as technically accurate as ever, that job is obviously incompetent, lacking in candor and actually a misrepresentation--radically misleading as to the essential facts. I do not say the soil facts but the essential facts. In Vilas county, and many like it, the future of the land and of the County was not, is not, and never will be primarily a matter of the soil. But it was so treated.

Actually it was as much a matter of red-hot politics as of soils. Actually it is a matter of economics. Sometime, I do not doubt, the bulk of Vilas will go back into forest, but for many years, I think, it will remain as it was in 1918 and as it is today--a butchered and burned and sandy desolation, with a few streaks and patches of loams included in the wilderness--a very marvelous site for summer resort development: worth a hundred times as much for that as for agriculture . . . It does not so appear in the report. It would have been highly inexpedient so to report. And are soil surveyors acquainted with the modern methods of recreational industry appraisement?

On through the other items the results are similar: no need for other detail. The soil surveyor has inadvertently undertaken a vastly bigger job than he can negotiate. Having failed, he is "in wrong".

In this contingency he seems to have three courses open. He may, perhaps, pass up those lines of work in which he finds himself untrained and incompetent.

Or he may decide himself quite competent to do all that is really required, and, by spreading himself thinner, may attempt to hold all he has preempted.

Or, having canvassed the field, he may decide that to be a really competent soil expert and surveyor is quite enough of a job for one man. Having arrived at that point, he may begin to cast about to see whether anyone else may be interested and of a mind to help with the big job. Then, if he is really interested in getting the job done well and promptly, rather than in picking a fight, he will not lack for able partners in a new and splendid enterprise.

Let me tell what has been going on in Michigan. The Michigan Academy of Science, including in its membership the most of the technical workers in the State, became interested, and appointed a committee to inquire into the State's land affairs. These were known to be unhappy. After inquiry, the committee reported back and the Academy adopted its report and recommendations and proceeded to give them life and backing. The essentials of those recommendations were these:

With a third of the State idle and non-productive by reason of ax, fire and failing or inadequate settlement, with great areas proven unfit for farming and other great areas known to have good soil, the first job must be to stop the fires which were keeping the lands idle.

Then the State must have an adequate land-development policy which would expedite the settlement of the really choice areas and keep settlement away from the dubious or hopeless lands.

Then the State must have an adequate forest policy, to get and keep continuously productive forests on the dubious or non-agricultural areas, and, incidentally, permit and encourage the increase in game, fish and fur which is always associated with safe green forests; with the increased game, and increased tourist or recreation traffic and industry, itself entitled to official assistance and development as truly as in the case of farm and forest lands and industries.

Now to build such State policies, said the Academy, it is obviously necessary that we have the facts--the essential facts as to the condition of these many millions of acres of idle lands. What we need is a real land inventory--not a mere survey. These lands will remain idle unless and until they can be put to profitable use in farms, for grazing, for forests or for recreation. An adequate inventory must cover at least all the principal factors which will affect the use of these lands for the several possible forms of utilization. To get such an inventory will require really expert and competent work by many specialists. Let's go!

So, now, in Michigan, the State Geologist is president of the Academy of Science. And under him, backed by the University, the Agricultural College, the Departments of Conservation and Agriculture, backed by many other organizations and interested individuals, all having been given a chance to contribute formulae and suggestions and specifications, and inventory survey has spent the summer in the field, tallying not only swamp and upland soils, but water-power, summer resorts, partridge, forests and farms, present and potential, all considered at the same time and by genuine experts in soils, economics, forestry, hydraulics, biology and so forth.

This first seasons work of course developed lacks and frictions, as was

inevitable and expected. But it amply demonstrated the complete feasibility of making a land inventory--a "soil and economic survey", if you please. And that, I take it, is what was described and advocated by this Association's Bulletin 2.

As the current soil survey evolved from a strictly non-utilitarian concept and developed a utilitarian branch, so now that branch grows, merges with the newly developed land economics, involves the engineering of land development upon a new scale--and still grows.

Discussion.

Dr. Marbut -

"I have very little to say about Mr. Lovejoy's paper. It shows that he has been doing a little thinking on the subject, but he seems to remain ignorant about at least one feature of it. He begins by stating that one point of view 'regards soil surveys as primarily intended to do for soils what Gray, for instance, did for our native plants, etc.' We who are doing the soil survey work wonder why he says that is one point of view, implying that there are others. We know that to be the point of view. We know that soil surveys are performed for the purpose of exactly that. We also know that there are certain by-products of the work that may and can and should be utilized for drawing conclusions not necessarily concerned with purely scientific matters but we know that these latter conclusions can not be drawn except on the basis of the results of soil surveys. Mr. Lovejoy himself will, I think, agree that the same institution performing the soil surveys may utilize them for drawing these conclusions and instituting practices conformable to them. Mr. Lovejoy is exactly right in admitting that 'soil surveys may be regarded as primarily intended etc.' He is not exactly right--he is not right in any sense--in implying that soil surveys are primarily intended to do anything else than what he mentions. After this primary object has been attained then other things may be done with the data assembled.

After threatening to annihilate soil surveys he turns suddenly around and expends a tremendous amount of energy in thrashing a poor little innocent sympathizer with soil surveys simply because it did not select the words by which it hopes to promote the interests of soil surveying with as much skill and discrimination as Mr. Lovejoy seems to think it should have exercised. The well meaning sympathetic bystander often meets with misfortune in this world. That is what he gets for being sympathetic and trying to help. His help must be skillfully performed if it meets Mr. Lovejoy's approval.

PROGRESS OF SOIL SURVEY WORK IN CANADA

By C. B. Clevenger, Manitoba Agricultural College.

In appearing before this Association it was my thought to acquaint you with something of the nature, method, and progress of soil survey work in Manitoba. The program committee, however, has enlarged upon my suggestion and have assigned in the subject a broader field. Although I am not prepared to say anything of the work in eastern Canada, I am familiar with the work in the prairie provinces as carried on by the Agricultural Colleges.

In Alberta, Saskatchewan and Manitoba soil survey work by the colleges is limited to the older agricultural and occupied lands. While the method of procedure in the three provinces has not been exactly the same, the mapping and classification of the soil is being conducted along lines as similar and alike as is possible for individuals to make them. It will therefore be possible as the work progresses to build up a unified system of soil classification which will increase greatly the value of the separate provincial and dominion surveys.

The soil survey in Manitoba as at present carried on began in the summer of 1921 as a part of a "General Agricultural Survey" of the Agricultural College, the purpose of which was to obtain facts relative to the profitable production of crops and livestock and also to general economic and social conditions. Under this plan fifteen separate areas or municipalities representing the various conditions and soil areas found in the province were selected for the study and investigation.

During the first season soil surveys of but six of these areas were made and at the end of the present season the field work for eight more has been completed making a total of 125 townships. The type of survey followed is between that of the detailed and reconnoissance methods. All roads are travelled by car and depending upon the frequency of them, depends the accuracy and detail of the map. Samples are taken and both mechanical and chemical analyses are made. This type of work furnishes sufficient information for the establishment of the correct types of soil within the province in knowing their extent and relative importance, and thereby aids in a rational planning of fertility tests and experiment fields. In both Saskatchewan and Alberta approximately a similar area as in Manitoba has been completed. In these provinces however the areas mapped have been larger and hence fewer in number. The larger area as the unit has the advantages of covering the ground more quickly when once a definite policy has been formed and of permitting a more thorough study of a particular section, the smaller unit however enables one to size up more quickly the soil of the province as a whole, and to acquaint one with the conditions with which he will have to deal.

Even with the short time the writer has spent in the field in the important agricultural sections of the province together with the chemical analyses completed so far, the information at hand is sufficient to warrant confidence in answering enquiries and advising prospective settlers. Because the results of the agricultural survey have not yet been published I can only quote from the Presidents Progress Report to the Provincial Government regarding Manitoba Soils. "The best soils of Manitoba have been found to be equal in essential plant food constituents to $400.00 per acre land in Illinois and

Iowa and they are richer than the Illinois and Iowa soils in organic matter. But there are many soil types in the Province and the poorest is but little better than the poorest in other parts of the world. Of those in cultivation some contain almost twice as much nitrogen, phosphorus and organic matter as others--the former are carrying and will carry prosperous communities; the latter are close to the margin of profitable production and will require super-marginal men to make them produce paying returns".

The chemical analyses show that of the soils so far studied the potential fertility is for the most part high. "It is this fact that warrants optimism for the future of the agricultural industry of the Province".

The outstanding features of Manitoba Soils are that they are for the most part of glacial or glacial lake origin, are well supplied with limestone and high in organic matter content.

The future development and further progress of soil survey work in the Canadian west seems promising. With the more or less unfavorable conditions for agriculture in the last few years, more attention has been directed toward the soil. While this is an opportune time to push forward soil survey work, yet it is also wise to proceed slowly and make sure that the work done merits and justifies its cost.

I should like to point out also that the relationship existing between the Universities and the Dominion Topographical Surveys Branch of the Department of Interior, at Ottawa is a congenial one. This branch in its field work of unoccupied areas is studying the soil and securing information for its proper classification. Of this work Mr. Hawkins will speak.

The Surveys Branch is also provided with facilities for the printing of soil maps. Through their willingness to cooperate with the Manitoba Survey, maps of the first six areas to be completed have been printed. I take this opportunity to express to them my appreciation of their work and efforts.

In the progress report of the Agricultural Survey of the College the President has recommended to the Provincial Government that soil survey work be continued until the settled areas of the Province have been surveyed. To what extent this policy will be carried out will depend upon the consideration the work receives from the present legislative.

Discussion

Progress of Soil Survey Work in Canada - C. B. Clevenger.

Mr. Hawkins -

"This is simply a matter of reporting progress. The Dominion Government's attention is being drawn to the fact that we are going to have a great immigration into this country and they are concentrating their efforts to get the knowledge and be able to place that before the people who come to us. Abandoned land is all economic loss and we can't stand any more economic loss. For that reason then, our soil work has been of a dual nature, we classify the land and at the same time carry on our soil survey. The soil work has been going on for two years in the west, but before that, in 1918, we started the classification work. The object was to provide land that was suitable for our

returning soldiers. The areas which are colored on the map are the areas classified. In connection with that, I would like to point out that we were fortunate enough to be able to employ men who had been trained under Professor Wyatt. Up until the present time we have classified seven million acres. The area is not large because in that land there is a great deal that is unfit for agricultural purposes. The object of the classification is to make it quite comprehensive, where roads are going to be, what clearing is going to cost, their possible market, and all such items which will be of interest to the coming settler. With respect to the work in the other parts of the Dominion, I think the time is coming when the provinces will cooperate."

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"What scale do you work on?"

Mr. Hawkins -

"Forty chains to the inch."

SOME NEGLECTED SOIL INVESTIGATIONS.

Hugh H. Bennett, Inspector Southern Division, U. S. Bureau of Soils.

The determination of the more pronounced physical and chemical characteristics of the soils of the United States, and the undertaking of classifying and mapping them by series and types is well under way. Heretofore emphasis has been put upon the more obvious soil properties, as texture, outstanding structural features, (chiefly friability, plasticity, and compactness), color, hardpans, character of subsections, drainage, content of lime carbonate and of alkali salts where these are present in excessive amounts. Chemical composition is being investigated in so far as analysis by the official methods permit. Considerable work has been done on the soil solution and the behavior of water-soluble salts contained in alkali soils under varying phases of concentration and salt complexity; but even these investigations probably have been carried to a point far short of complete solution of the problems involved. Soil colloids are receiving much attention at this time, as are also problems of hydrogen-ion concentration, nitrification, the bacterial life of soils, and so on.

It is not proposed to attempt a cataloguing of what has been done, nor of what remains to be done in the field of soil investigations. It will be undertaken to indicate briefly, suggestively, and perhaps argumentatively, some lines of soil study, that seem to offer productive ground from which illuminating and helpful results may be obtained, and also to point to some investigations which seemingly are not being pursued in the way that will yield the most valuable turnout of scientific facts. These suggestions have not been checked against the literature. It is not improbable that more has been done in some fields that will be referred to than the author of this paper is familiar with. Even so, no harm will be done, it is hoped, by calling attention to problems which may not be well understood by all of us.

Much of the work accomplished in the past undoubtedly has been of an exhaustive kind, carried in some instances to final conclusions, or approximately to that end. On the other hand, many lines of investigation have not been extended to a point anywhere near finality and others only so far as to indicate need for much additional research. It seems desirable to emphasize the fact that much laboratory work has been carried on not upon soil types but with soil material, removed from its native situation, crushed beyond all resemblance to its original condition. Soil material of this kind is suitable for chemical and mechanical analysis, if the samples have been properly taken, and for the determination of various principles of soil physics; but for the study of such things as permeability, internal movement of moisture, and rate of leaching, this kind of material is not at all suitable, it would seem, in so far as the results relate to soil types as they exist in place. The farmer needs facts which relate to the behavior of soil moisture in the field rather than in parcels of earth carried to the laboratory in a state of fineness no farmer can hope to convert his two feet, or three feet, or four feet of soil.

Even some types of sand cannot have all their physical properties determined by experimentation with the finer soil material, because some of them, as the Miles fine sand of the southern Great Plains, harden in dry

seasons to a condition which causes the land when plowed to break into clods of considerable strength.

So there is much unfinished work relating to the physical properties of undisturbed soils, that is to say, of their subsections, hardpans, clay pans, and substrata, the interreactions of these under varying conditions of dryness and wetness, and the sum of their effect upon the productivity of the type.

Probably blocks of the undisturbed soil could be taken into the laboratory, if necessary, or, if this can not be done satisfactorily, it does not seem there should be insurmountable obstacles in the way, of carrying on investigations in the field, where the crops are grown and where the farmer deals with soil types rather than with parcels of pulverized earth. As a matter of fact, the field is the ideal place, if not the only possible place, where results can be obtained that will surely fit the soil type.

. . . .

Some of the very sandy soils of the Great Plains, highly quartzose and of low lime content, such as the fine sands of the Amarillo and Miles series, and even dunesand, harden on drying, often to depths of several feet, whereas soils of similar texture in the humid region show little or nothing of this tendency. Is there some binding action by traces of colloids or of contained salts peculiar to the drier regions? The deep sand of the Monohans Dune near the Pecos River in Texas had a decidedly hard structure during the drought of this year to depths of more than five feet. This sand is very quartzose, not the faintest indication of effervescence with hydrochloric acid was noted, nor was there any evidence of salt incrustation, yet the hardness extended from the surface or within two or three inches of the surface downward. No analysis of this sand while in this condition has been made as yet, but samples have been taken for this purpose. If the hardening is due to watersoluble salts, it will be interesting to have corresponding data for a season of less drought when, it is claimed, the sands are not so hard. Is there more salt present in a dry season than in a wet, and, if so, where does it come from?

. . . .

Caliche is found beneath vast areas in the Great Plains, occurring at depths ordinarily ranging from a few inches to four or five feet. It occurs beneath areas so nearly level the eye can detect no gradient and where there is so little evidence of erosion that not even an incipient drainageway exists in some whole counties. The thickness of the caliche section is as much as ten feet or more in places. It is twenty feet along the escarpment of the Llano Estacado northwest of Spur, Texas. Here the material is very largely composed of lime carbonate, whitish to light pinkish in color, hard above and chalky beneath.

How has this caliche accumulated? Has it been by decomposition of the soil minerals, leaching and subsequent precipitation of dissolved salts at lower levels or has it come from beneath dissolved in moisture gradually moving upward from the substrata to be deposited somewhere near the surface during dry seasons by evaporation of the salt-laden solution within the dry soil zone? Perhaps both processes have contributed to the accumulation. Possibly subterranean water flowed nearer the surface formerly than at present. There are subterranean waters at no great depths now in some localities and these are

highly charged with lime, as in the Plainfield, Texas, irrigation district and in springs like those at the headquarters of the Spar Ranch in Dickens County.

In Reeves and Pecos counties, Texas, and in some of the adjacent counties east of the Pecos River the caliche contains much gypsum, and this salt is present locally far east of this locality. In places along the escarpment of the High Plains highly siliceous beds are associated with the caliche, pure flint in some localities, as along the north fork of Wildhorse Draw, in Howard County. The caliche often overlies hard fossiliferous limestone, especially along the northwestern edge of the Edwards Plateau; again, it overlies Permian Red Beds. It might be said that the material scarcely could have been brought up through dense sedimentary limestone, yet it conceivably could have come up through cracks and have been spread out in solution over the rocks.

. . . .

This brings up a point it is desired to emphasize, namely: There is need for more knowledge about the nature of soil solutions under varying climatic and seasonal conditions, and also about any upward and downward movement of salts in solution that may conform in some degree with the season and with the soil. Do salts move upward in solution to be concentrated near the surface in dry seasons, and do they migrate in the opposite direction in wet seasons? Are there places where more comes up in dry or hot weather than goes down in wet or cool weather? If in the Plains a section of soil should be removed and a corresponding thickness of powdered quartz or of fine quartz sand of known chemical composition put in its place and protected from undue accumulation of wind-blown material, would there be any accumulation of salt after a year or more? Do alternating high and low temperatures of day and night and of summer and winter have any pulsating or other influence upon moisture movement in soils?

Undoubtedly some valuable data could be obtained from studies along this line, relating both to leaching and to the almost unexplored field, in this Country, of upward moving salts from unknown depths. The results of many analyses of drainage waters are available but there is not much available soil-type data dealing with the performance of upward-moving capillary moisture. Much chemical data is available for the surface six inches and for other arbitrary soil depths, and these are often used as if these layers represent the ultimate productive capacity of the type without relation to the soil material beneath or to salts contained in moisture that may under undetermined conditions rise from undetermined depths. Possibly that which comes from beneath is of little importance or is overbalanced by what goes down; nevertheless it is interesting to speculate about it.

. . . .

There are some other interesting things about soil moisture behavior or crop behavior under extremes of moisture in dry regions, as compared with humid regions. Take cotton, for an example: In the southeastern part of the Cotton Belt this crop would literally parch under conditions of drought through which it thrives in the extreme western part of the belt on soils of the same texture. This year in late July a week of dry weather varying from about 88° F. to 95° F., with a moderate breeze on two days, caused marked yellowing of

cotton leaves and shedding of the squares on a clay loam soil in southern North Carolina. In west Texas this year the leaves of cotton were generally green well up into October in fields that had received no rain after the plants came up, and there was very little shedding of the forms even though temperatures ranging from about 90° F. to 106° F. had prevailed for week after week, and the wind had blown almost incessantly as moderate to stiff breezes. The plants remained deep green, continued to blossom, and shed practically no forms until around the 25th of September, not only on clay loam soils but on heavy clays. About this time some deterioration sat in, or rather blossoms began to be less plentiful, a few squares dropped off, and some of the leaves turned yellow. By the first of September fruiting had about ceased, and bolls were cracking open, especially on residual, stiff, red land. One field on Simmons clay in western NolanCounty, Texas, averaged about one-third of a bale per acre and the leaves were still green in October. Here the soil was cracked deeply, and there was no apparent moisture to a depth of 40 inches. There was some moisture below this, but to this depth the soil seemed to be air-dry. That field had, at the time of planting, a good initial supply of moisture from spring rains. Cotton suffered more in this region on the Vernon clay loam and shallow fine sandy loam, which soils have structural characteristics more like the soils of the humid region, that is, they harden more and crumble less on drying out.

Cotton simply does not behave in this manner in thé eastern part of the belt; in dry seasons it sheds enormously there, even where the soil apparently contains much more moisture in the subsoil. Adjustment to climate undoubtedly has much to do with the greater drought resistance of the crop in the west. The leaves of the plant seem to be thicker than in the east. A plant physiologist familiar with both regions gave it as his opinion that the plants of the Western belt develop morphological differences through processes of adjustment to the environment.

. . . .

Prevailingly, the soils in this southern part of the Great Plains act in quite a different way structurally from soils of similar texture in the humid region, the heavy types cracking and subscracking or crumbling to form the equivalent of a well pulverized surface layer, as against the usual tendency of the wet-region soils to become hard and intracticable. This is true in this western section not only of soils rich in lime carbonate in the surface layer but of those, also, low in lime carbonate. The eastern soils of low lime and ordinary organic content plow up, when dry, into clods which are most difficult of reduction, necessitating repeated harrowing and disking. In the western region, on the other hand, all clods break into fine clods or very fine soil aggragates at the first rain. With many types the clods slacken without rain and without tillage. San Antonio clay loam near Kerrville, Texas, which had been turned up in a very cloddy condition in September, this year, had about crumbled down to what would be called a good tilth a short time after the plowing, although there had been no rain. Essentially the same thing happened at the Spur Experiment Station with the Miles clay loam. Huge, intractible clods were seen at the San Antonio Station on Houston clay loam; but these were not worrying the superintendent, who said they would crumble to desirable fineness with the first rain.

Tillage investigations seem to indicate that mulching in this dry country is not of so much benefit to crops as hitherto has been supposed. This may have

some relation to physical peculiarities of the soils, at least for the heavy types of the Miles, Abiline, Simmons, Richfield, and Amarillo series. These are self mulching soils, if the term may be used. It has been explained how they crack and crumble, on drying, to a desirable tilth. This tendency is not so pronounced on the virgin types, yet it obtains to some degree on these also. At the Spur station the cultivated, hoed, and uncultivated plots of Miles clay loam had about the same structure when examined at harvest time, this year--a year of drought. Indeed, the soil over the entire station was so loose to a depth of two or three inches that it could be scraped up easily with the hands. No kind of cultivation could have made it finer. Below this depth the structure was essentially the same under all the plots, that is, fine-cloddy to small-cloddy. Cotton on the plot where the only cultivation was weed destruction by the hoe was somewhat better than where there had been frequent shallow tillage.

The deep sandy soils of this region, particularly those supporting a native growth including much shin oak, have the reputation of conserving moisture better than most of the heavy soils. Quite satisfactory crops of cotton, and frequently good corn are obtained from these sandy soils. Once cultivated, this land is inclined to maintain a fine surface throughout the season, unless crusted by rains; but it is possible cultivation materially assists in the conservation of moisture. No data are at hand to check this.

Rotmistrov[1] at the Odessa Experiment Station in Ukrainia, working on "chocolate colored clay containing 3 to 6 per cent of moisture" ("my results may be transferred to all black-earth soils resting on beds of fibrous clay such as the Russian steepe belts of the south and the black-earth Governments of the East") finds no evidence of capillary water rising up from deep soil layers, that is, layers below which roots penetrate; that water percolating beyond a depth of 40 to 50 c.m. does not return to the surface except by the way of roots; and that" all the water not seized by the roots goes down into the deep layers." With some plants, he says,"by midsummer all the reserve of serviceable water in the root layer is utterly exhausted". Some other plants, as potatoes, do not use up the serviceable moisture so rapidly.

He recognizes at Odessa: (1) a "periodically humid layer"; (2) beneath this, at a depth of 160 to 180 c.m.an "intermediate dry layer", almost constantly dry or containing only "useless water"; and finally at 160 to 180 c.m.; (3) a "permanent humid layer", containing 2 to 3 per cent of "useful water" in the upper part 7 to 8 per cent in the lower part, this humid layer extending to ground water.

Some of Rotmistrov's conclusions are that: "the only water that can accumulate in the soil is that which enters it from the atmosphere", and that this can be conserved best by the unsparing destruction of weeds in fields throughout the whole year and by the practice of crop rotations "based on the principal not only of seed change but also of root change". When the soil has dried out to a depth of about 30 cm. he appears to believe that the

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[1] The Nature of Drought: V.G.Rotmistrov, Director Odessa Experiment Field, 1913 (translation from the Russian).

condition of the surface soil can have no important subsequent influence on the store of moisture for that period of drought. He refers to possible movement of moisture by vaporization, but seems to assign no special significance to this.

In soil survey work the relation of soil type to cultivated crops has been stressed. This has been the natural thing to do, yet it is believed other adaptation studies of interest and value could be carried on. By reason of unconscious oversight or perhaps by simple neglect the relation of soil type to flora, as concerned with forest trees and plants other than those of better known economic importance, has not yet been carried much farther than the mere noting of isolated instances and an occasional discussion of some of the broader aspects of soil-plant relationships, far short of a systematic, comprehensive investigation of soil-selective tendencies on the part of plants and of the full soil effect upon plants as expressed in the character of the native vegetation. The soil student occasionally has dealt in a general way with such plant matters as the preference for acid soils by ericaceous plants, and at rare intervals has referred to calcific, xerophytic, lithophytic, psychrophytic and other classes of vegetation; but in the final analysis it will be found the soil surveyor has not exerted himself along this line. Plant men have done considerable work of a phytogeographic nature; but they have not brought out the precise relationships between plants and soils, probably because they have not known soils. A more active cooperation between the soil surveyor and the botanist and forester seem imperative, if best results are to accrue from studies in this field; but the soil man himself unquestionably can accomplish much more than he has done thus far.

Ashe lists 47 forest types in the southern Appalachians, giving their location and tree composition, in a recent paper[1] pointing out the desirability of preserving areas of these types to be held for reference and as a guide for futher work. "Such vestigial units" he says "would serve as check plots for the forester and would preserve basal forest data of herbaceous as well as of ligneal species for the biologist". In another paper[2] the same authority correlates many of these types with the slope drainage condition, and in a broad way with the soil. It would be interesting, and probably helpful to forestry, to know the precise soil characteristics with which these types are associated. In this connection, it might be added that foresters contend that soil surveys would be of greater assistance toward the cause of forestry, including the reforestation of idle lands and lands unsuited to cultivated crops, if the reports were more specific in giving the comparative values of the less promising soils as between cultivated crops and tree production. Much more specific recommendations along this line easily could be made in the average soil survey report.

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1. Ashe, W. W., Reserved trees of Principal Forest Types as a guide in developing an American Siliviculture, Journal of Forestry, Vol.XX, No.3, March,1922.

2. Forest Types of the Appalachian and White Mountains, Journal of the Elisha, Mitchell Scientific Society, Vol. XXXVII, Nos. 3 and 4, 1922.

Is very much known about the comparative rate of erosion of soils having similar texture, struction, and topography? What is the coefficient of erosion for the Susquehanna fine sandy loam as compared with the Cecil fine sandy loam of similar surface configuration?

Those soils of the Cecil series having a substratum of disintegrated granite or gneiss are cut into by erosion with much more destructiveness than are the Hagerstown soils occupying similar slopes. Those soils having, at depths of something like 3 to 8 or 10 feet, a substratum which is markedly coarser and looser than the overlying material are subject to much more disastrous washing than those having no such substratum. Once gullies have cut down to the loose material, land dissection takes place rapidly upon all unterraced, tilled slopes. Other types with shallow soil over stiff impervious clay are more susceptible to wasteful washing than those soils with more friable subsoils, except where the substratum is excessively friable or loose.

These are some of the broader features of soil erosion. There is not nearly enough correlation between erosion and soil type. More information on this subject could be collected in most of the areas surveyed than usually appears in the soil reports. It is rather the general rule to say little or nothing in the reports about the enormous waste effected by that relatively slow type of erosion which goes on upon nearly every cultivated slope. This sheet erosion does not impress itself in conspicuous gullies. It reveals its earlier destructiveness in little exposures of unproductive, raw clay or subsoil here and there in the fields, and its final effect in exposures of bedrock, such as can be seen in places in the Bluegrass Region of Kentucky, the Black Waxy Belt of Texas, and the Piedmont from Alabama to southeastern Pennsylvania.

This erosion does not select the inert soil material and leave the valuable constituents of the soil behind. It takes the whole mass, particle by particle, lump by lump, slowly but surely, and sweeps it away to the stream bottoms and to the sea. The loss of plant food in crops removed is very much less than that removed from fields by erosion. It is regretable that comparable figures are not just now available. Rough estimates can be made readily.

Looking into the matter of the area destroyed or practically destroyed by erosion in the Southeastern States, it was not possible to find anything more in the literature than some estimates based, seemingly, upon isolated, casual observations in no way tied up to definite surveys. Some hasty calculations by the author of this paper based on rather fragmentory survey evidence indicates for that section of the country the essential destruction of considerably more than five million acres of land, most of which formerly was farmed.

In a single county in the Piedmont 90,560 acres have been classed by the soil survey as rough gullied land. This was once considered good farm land. Unwise tillage of the slopes, without practice of counter-erosion methods, has converted this to forestry and grazing land. The practical abandonment of approximately twenty five per cent of the area of a county in the Coastal Plain has been brought about by similar methods. Much of this land by reason of its peculiar susceptibility to erosion should never have been tilled. It originally was good forestry and grazing land, now it cannot be cultivated, although

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a good crop is growing on some of it, and should be growing on all of it. That crop is the pine tree.

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The relation of soils to plant disease has been given but little attention by the soil man. Here the factors involved probably have seemed essentially biologic and outside the domain of the soil scientist. Unquestionably obsticles would crop up immediately in this field, and without the cooperation of the pnytopathologist, little headway could be made. The field seems, however, sufficiently promising for at least more attempts at correlation of soils and plant diseases. In the southeastern part of the Cotton Belt, for example, the cotton wilt disease does relatively little damage on the heavy soils, but in Texas a great deal of harm is done on clay and clay loam soils.

It is not at all improbable that errors in diagnosis of plant troubles have been made. Worms were said to be the cause of a marked inferiority in some pecan trees on a portion of an orchard visited in central Mississippi the past summer. There were no worms in evidence, but when the soil was examined that on which the inferior trees were growing was found to have an extremely compact hardpan at a depth of about two feet, and, of course, poor underdrainage, while that on the site of the vigorous trees, which were twice the size of the inferior ones of the same variety, planted at the same time and given the same treatment, was a well-drained fine sandy loam without hardpan. At the surface the soils of this orchard had about the same appearance; in the subsoil it could scarcely have been more dissimilar. Here the trouble unmistakably was with the soil.

Pecans and peaches do not thrive on soils with intracticable clay and hardpan subsoils, yet some of the hickories, oaks, gums, and other trees seem to prefer sites of this nature. The apple will produce abundant tree growth on soils of inadequate underdrainage, but the trees are not so vigorous nor so fruitful as on soils with better subsoil aeration and penetrability.

Does the content of iron in soils, or its chemical state, have any connection with chlorosis troubles? Some recent observations would indicate that it does; but no analyses are, as yet, available for the samples collected from an area where a number of plants were suffering during the past summer with this disease.

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Highway engineers have said they are in need of practicable methods for measuring the structure of certain soils which are unsuitable for surfacing and unfavorable as a road foundation. They are most interested in methods of instrumental measurement, such as can be used along the roadway by engineers. It does seem that means could be developed for the determination of coefficients of plasticity or permeability, for example, for various clays and other refractory soils or soil sections of varying moisture content. Measurement of resistance to penetration by a standard metal pin might serve as a starting point.

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And so on, there are many fields for investigation in which the soil man

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appreciating the meaning of soil types should be interested, if not active. Indeed, the opportunities for special study are so varied, that one can scarcely hope to accomplish much except by observing some degree of specialization. The time has come, it seems, for soil survey men to begin to specialize. Instead of a large number studying organic soils, alkali soils, sand soils, and so on, spasmodically, as the opportunity offers, would it not be better for a few to do some systematic work with one or more special groups of soils?

Something could be done to encourage this by assigning the men, when practicable, to those areas that include soils of the kind they may be specializing in or keenly interested in. A step farther would be special assignments to these studies.

Usually there is not much available time for special investigations by the field man during the progress of a soil survey, the soil man being required to function as a soil expert, civil engineer, general agriculturist, writer, and Ford specialist. There will be opportunities in most surveys, nevertheless, to do a little more than that which is directly applicable to the soil map and report, provided one is interested and keeps one's eyes open for special problems or additional information along the line of a special study of a group of soils one may be particularly interested in. The outcome of any extra effort along this line may be the obtaining of valuable auxiliary data for the report, or for a special paper which would be complementary to the report. The field men should be encouraged along these lines.

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There is another field in which the soil survey specialist could do very much more work than he is doing. This is the professional field-the field of soil engineering. These specialists are the only real soil engineers in existance. Many others profess to know all about soils; some do know soils in limited localities; but the greater number know little about them, further than something of the surface appearance, even in restricted localities. The method of attack employed by the soil survey specialist is the only sure method of getting deep into the soil and of determining the economic significance of soil distribution by soil type. If the soil type is left out of consideration, that means an element of fundamental and paramont importance to land economics has been neglected.

The experienced soil surveyer can go upon a tract of land and make a report upon its suitability or the suitability of its various bodies of soil types to agriculture, which will be valuable to the prospective purchaser of that tract, particularly in the case of untried lands, in just the same way that the timber cruiser's report upon the quality and quantity of timber on a body of land would be valuable to the prospective purchaser of the timber.

A soil chemist familiar with the soil survey method recently was called to an island of the West Indies to examine the soils of a large sugar plantation, which had been purchased some years previously by Americans, fenced, cleared and planted extensively to sugar cane. There were forty thousand acres in the tract. Its boundaries had been carefully surveyed by civil engineers, who also had mapped the topography, and planned and put in an extensive irrigation system.

Things went well for a time; the cane grew off nicely. Then out of a clear sky trouble appeared. The cane began to die, where previously it had flourished. The civil engineers could not put their hands on the sore spot-there were forty of them on hand when the soil man came along.

The trouble was alkali. It came up from the substratum after excessive use of irrigation water.

Then the soil man developed some plans for an attempt to improve the situation by flooding and underdrainage. He also relieved his mind of some accumulated spleen against the usual method of developing untried agricultural land, that is, the civil-engineer plan rather than the soil-engineer--civil-engineer plan. He told the plantation owners they should have left about twenty thousand acres of the forty thousand acres outside the fence as representing extremely unfavorable soil. He told them, also, with the climate characterizing the region; they should have looked first of all for alkali, then, selecting the best soil, prepared adequate outlets for drainage and used irrigation water sparingly instead of profusely.

The point is: We soil survey people have a line of engineering which is of the most practical value to agriculture, yet we have not been given anything like the full recognition deserved, particularly in the field of practical service to those acquiring, developing, and cultivating the land. We, nevertheless, are doing work of great importance toward agricultural advancement--that piece of work which is positively essential to a proper adjustment of agriculture to the land, in so far as correct soil usage is concerned--and correct soil usage is very deeply concerned.

Discussion.

Some Neglected Soil Investigations - H. H. Bennett.

Dr. Marbut -

"The Spectator once said that one of the great needs in the world was money to carry out the ideas we already have. If all Mr. Bennett's ideas were carried out, I am afraid Congress would be more surprised than they are at the money it would take. He has certainly given a long list."

"Regarding the study of alkali soils. We have been mapping soils in regions where there is alkali wholly and absolutely on the same basis as the soils of the humid region, without reference to the effect alkali has on the soil. Then after the soil has been mapped, we determine the percentage of alkali and show where these regions are. We have not yet mapped the soil on the basis of the soil profile, which itself has been determined by the presence of the salts. We map it on the same basis as other soils without reference to the alkali. We need some studies right now to determine the effect alkali has on the structure and the profile of the soil."

Mr. Lapham -

"There is one thing that has stood in the way of the study of alkali, the fact that alkali is not a permanent thing, it is here today and gone tomorrow."

Dr. Marbut -

"There are alkali soils, and there are soils with alkali. The two things are entirely different."

PUBLICITY.

By W. E. Hearn, Inspector Southern Division, Bureau of Soils.

Several years ago the Bureau of Soils had a Press Agent, and it was generally understood among the employees that nothing was to be given to the press except through this agent. However, I am glad to say that this was of short duration, and that today each and every one of us are free to explain the work and to give articles to the papers. Publicity is a great thing and no business can profitably exist without advertisement of some kind. No scientific work can long continue unless the merits of it are known to those who appropriate funds for carrying on such work. Now if we expect the soil survey to live and grow, it is necessary that it be advertised.

It is a foregone conclusion that press notices in the daily papers, county papers, farm papers and in the new letters of the experiment stations and colleges are essential and bear fruit. We also need favorable articles in the popular weeklies, like the Country Gentleman and Saturday Evening Post. Any great hallabaloo or skyrocketing advertisement of the Soil Survey is not for the best interests of our work. We have passed the stage of exploitation and are living in an age of development and accomplishment.

All of you know the beneficial results of the Soil Survey in your respective states, but permit me to call your attention to a few things that may not be generally known. When the Soil Survey work began in North Carolina in 1900, the Experiment Station was located at Raleigh on one or two soil types. As soon as the Director and his co-workers ascertained through the soil Survey that there were several large and important types in the state, five branch stations were established from the seaward portion of the Coastal Plain to the mountains. The field experiments with fertilizers on the Cecil soils at one of these stations revealed the fact that potash in the fertilizer used in usual amount did not give any appreciable increase in the yields of crops--except for such crops as tobacco and Irish potatoes. This information has saved the farmers in one year more than the cooperative Soil Survey work has cost for twenty years. I could mention other things of equal importance.

The Soil Survey has done a great deal to take fakism out of the operations of land sharks and to give to the people accurate descriptions of soils. It is a matter of record that from about 1909 to 1912 land agents sold something like 80,000 tracts of 10 acres and up in size in the Everglades of Florida. Most of the material sold consisted of Peat and this was largely covered in water and had a dense growth of sawgrass. People from practically every state in the Union purchased this Peat. It was represented to be extremely fertile--comparable to the soils in the valley of the River Nile. The land agents were prosecuted by the Department of Justice for the fraudulent use of the mails. Men from the Bureau of Soils examined, mapped out this material, and gave evidence in the courts.

Only last year the Bureau of Soils was instrumental in saving the Government about $510,000 on the purchase through condemnation of a portion of the land included in the Camp Bragg Artillery Range near Fayetteville, North Carolina. The appraisers appointed by the War Department placed a value on

the land while another set of appraisers selected by the Federal Judge gave a different figure. The Soil Survey men made a thorough examination and map of this land and presented evidence in the Federal Court on the value of such lands and our estimate was near the price paid.

Again, last year Texas and Oklahoma were involved in a serious boundary dispute. The case was brought up in the Supreme County. The main point was the determination of the location of the south bank of the Red River. Processes of flood plain building and wind action upon soil material entered the argument. The soil survey men--two of whom are here today--were called upon to locate the buried river channels and islands to determine the source of materials and to identify wind blown and water laid beds and to testify as to the relative age of the materials. Geologist, Botanists, Geographers and various engineers worked on the case but it remained for the Soil Survey men to give the most significant testimony upon the most fundamental problems involved.

Should not the work of the Bureau of Soils and the soil work of the various states be known to every reader and thinking person in the United States? Is it not a fact that the directors of the experiment stations and leaders in agricultural workers recognize that the Soil Survey is one of the most important and valuable lines of work which is being done by the Agricultural Department? Therefore why don't we inform the people of what we are doing so that those who appropriate money for our work would be willing to increase the amount annually instead of decreasing it. Let us get busy and advertise our work.

I have had my ears to the earth, so to speak, as well as my hands, for more than twenty years, and taking the sentiment of the leading agricultural men in my territory I am led to believe that the consensus of opinion is that good work is the fundamental basis of our existence. Therefore, the best advertisement of the soil survey is good work--work that will stand criticism and mean something to the agricultural development of our country. The soil survey work which we are doing to-day is the best since the morning of its history, and while most of us feel proud of it, yet we are not content, but shall push forward toward a mark of high efficiency, forgetting not the practical uses of the survey.

To obtain good work we must have trained men who are interested in and love the work. We should pay them better salaries and always encourage them in their laudable undertakings. Our field men work hard, put up with hardships, and rush from one area to another. We do too much work and too little advertising.

The men in the county or area can impart knowledge about the work. They should be friendly with the county agent, state representative, leading agricultural men,, prominent business men, and should frequently prepare short notices about the work for the county paper always keeping the work before the people. I visited an area several years ago and found practically no one in the town or county who knew our representative, or had heard about the work, except the postmaster, liveryman and hotel proprietor. I am not saying this to criticize the party, but to call attention to the fact that this is not the proper way to conduct the work. The people pay for this work and they should know what is going on upon their farms, or in the county. It is not necessary to spend a lot of time with the people but enough to inform them of the work. In other

words, all we have to do is to display a little common sense or horse sense.

In going over the county the field men are asked questions about the work by hundreds and perhaps thousands of people. Therein, lies the golden opportunity for the men to advertise the soil survey. They can tell the farmers or others in a minute or two what the maps and report show, and how they can secure a copy of same through their Congressman or Senator. So I say, the men in the field can best advertise the work, just as a polite, and courteous salesman can bring business to his firm or just as an honest and reliable mechanic will cause you to drive several blocks out of your way to have him work on your car.

One of the greatest assets or advertising mediums of the Bureau of Soils today is its strong and friendly cooperation with the heads of the soils departments of the various states and of the State Experiment Stations and Agricultural Departments, and let us cultivate their friendship more closely. They are exceptionally fine men and it is always a pleasure to associate with them. We are cooperating with a large number, and others desire to come in, but we have not sufficient funds to extend our cooperative work.

Our reports should be written in plain simple language including more practical information of direct benefit to the farmer or prospective settler. This should be separated from the highly technical part. Again our soil maps and reports should be published and sent to the people before they have forgotten all about the work. Two to three years is altogether too long a time between actual work and the sending out of reports.

Now, Gentlemen, allow me to insist that we combine as a unit and do this personal advertising in connection with our regular work, and in addition to the regular press notices.

Discussion.

Publicity - W. E. Hearn

Mr. Gray -

"I think that this matter of local advertising presents itself to all of us, and we wonder how best to do this. I think possibly some direction along this line by someone who is more in a position to handle matter of this kind would be better. If a newspaper man asks about the work and you don't write it up yourself, it is badly twisted. In one place where I was working, I took two of these soil survey bulletins and pasted them together and pinned them up in the postoffice. I saw a lot of people gathered around them, and I imagine it advertised the work a little."

Prof. Geib -

"We sent out a notice to the county papers and then went to see these papers and the farm advisers. We put up a notice that if anyone wanted their soils tested we would do it for them, and we had a demonstration on Saturday afternoon in the Farm Bureau office, and put up these analyses with the name of the man whose farm it was. This was practiced at county fairs also."

Dr. Marbut -

"The field man must not have the burden of advertising laid on him. He can do an immense amount of advertising by doing his work well and conducting himself well."

Mr. Bushnell -

"We tried one plan. we fixed up a card to give the farmers something to read or something to explain why we were there."

POSSIBILITIES OF THE AIRPLANE IN SOIL SURVEY WORK

By W. B. Cobb, Louisiana.

The statement that soils may be mapped from the air may sound absurd, but the fact that such a thing has actually been done puts the matter in a different light. Of course the mapping of soils is best done on the ground, but there are a good many ways in which a soil map may be improved from the air and there are certain phases of the making of base maps that cannot be done accurately except from the air.

There are two ways in which an airplane may be used to advantage in soil survey work. One of these is by enabling the surveyor to make direct observations from the air and the other is in the making of aerial photographic maps which may be used in the preparation of base maps and for reference during the survey and the final drafting of the soil map.

The profitable use of airplanes for these two purposes may be limited by certain factors. In an area which is covered by an accurate topographic map or in a prairie country where the roads are regularly on the section lines and where other land lines are easily followed an airplane would be of doubtful value. However, in an area containing considerable timber, swamp land, inaccessible streams, roads which do not run on section lines, shore lines, lakes, &c, an airplane will greatly facilitate the work and materially increase its accuracy.

Aerial work without a camera will consist largely of checking up on ground work and should be done after the plane table traverse has been made. At this time the surveyor is familiar with the area and he knows what part of his work he is in doubt about. By this time he knows the soils so that many of them can be recognized at a glance. He knows for instance, that all of a certain type is cultivated, occurs on ridges and has a grayish appearance. He knows that another soil is always timbered to hardwoods, another to pines. He knows that certain soils border streams as areas of high land and others as areas of swamp. He knows that he has accurately located the boundaries of these soils in places but that in between these locations the boundaries are merely sketched in. With this knowledge in mind the soil man can take his field sheets into the air and considerably increase their accuracy. He may find that the strip of bottom land varying from a half mile to a mile in distance from the road he has traversed and to which he has made several foot trips counting paces does not have amore or less wavy line as the boundary between itself and the upland, but a very irregular line which he may sketch in with considerable accuracy from the air. Corrections or additions to a plane table sheet or base map are easily made from the air. An airplane in flight is much steadier than a Pullman car in motion, and the altitude at which observation is done makes it possible for the observer to keep his eye on one spot on the ground for a considerable time. Making corrects on a map from the air is like copying from one map to another.

The correction of stream courses and water fronts is very satisfactorily done from the air. A Coast and Geodetic Survey map locates certain points along the shore with almost absolute accuracy. Between these accurately located points or triangulation stations the shore line is sketched in as it looks from

the water or from points on the shore. It is reasonable to expect that this sketching can be done more accurately from the air, and such I have found to be the case. In one instance I found a shore line a quarter of a mile off. In another case the coast surveyors had mistaken a bulge in the handle for a body of water known as "The Frying Pan" and had left this three or four square miles of water entirely off the map. You can't miss a duck pond when looking down from an airplane three thousand feet up.

Very crooked streams running through timbered alluvial lands or swamps cannot be accurately mapped from the ground. Even the civil engineer with transit and crew of men will frequently make mistakes. He may cut across a curve in a stream and connect the two known points with a regular loop when as a matter of fact there may be two or more loops. The observer can take the surveyor's map into the air and make the necessary corrections in a few minutes.

The checking up on ground work which I have described can be done in one or two flights around a county and is a matter of aerial observation. If the soil surveyor himself is not an aerial observer it may take a little practice to handle the work successfully. Also there are some men who prefer to stay on the ground. In this case an aerial photographic map of a county could be made before the beginning of the ground work. These maps are generally made at a scale of 1/7000 by using a camera with a 12 inch focal length and flying at an altitude of 7000 feet. This scale is approximately 9 inches to the mile. A map on the scale of ten inches to the mile can be made by flying at an altitude of 6336 feet with the same camera. This larger scale would add a little to the expense, however, and for soil survey purposes a smaller scale, 5 inches to the mile for instance, might be more satisfactory.

The photographs are taken so as to overlap one third each way and are matched and mounted. The large map, or mosaic as it is called, may be photographed down to the desired scale. A base map may be drawn from the photographic map which will save the time required to map towns, traverse roads, &c. The exact courses and widths of the streams are had without the necessity of traversing them. The exact amounts of cultivated, timbered and marsh land can be determined, and the boundaries between areas of upland and alluvial soils, the extent of swamps, shapes of lakes &c, are shown accurately. In the south you can determine the topography fairly well from aerial photographs. Square fields and straight rows indicate level or nearly level land. Contour plowing indicates slopes. Terraces indicate steeper slopes and terraces close together indicate still steeper slopes.

When the soil boundaries are located on the base map drawn from the mosaic, a comparison will enable the map compiler to determine the exact per cent of cultivated and uncultivated land of each soil type. At present the field man guesses at or estimates this. The general character and thickness of the timber can also be determined. Paths and trails through swamps and other timbered areas show up distinctly making it unnecessary to hire a guide when these areas are entered for the purpose of mapping the soils.

Now that I have attempted to show that better soil maps can be made with the help of an airplane the question naturally arises: Can this work be done economically? I believe that it can. Considerable time can be saved and considerable accuracy can be added to the work. After having flown over Dare

County, North Carolina in a seaplane I am convinced that I could map the county in a month by using a seaplane two or three days and a motor boat the rest of the time. Without the aid of a seaplane three or four months would probably be necessary. This is an extreme case, but the proper use of an airplane would save considerable time.

Unfortunately I am unable to give exact figures as to costs. Information on this point expected from the Army Air Service failed to reach me before I left Louisiana. However, I am sufficiently familiar with the work to make approximate estimates. An area of 400 square miles would require about 1200 7 x 9 exposures. Film cameras are used and a roll of film can be used for 100 exposures. Three hundred and sixty dollars would probably cover the cost of the photographic end of it. Nine or ten hours flying would be necessary. This would cost approximately $500. If many retakes were necessary of course the expense would be greater, and if a commercial concern should be employed for the work a reasonable profit would have to be added to this.

The photographic maps could be used not only for the making of soil base maps but also for the making of new and the correction of old geological, topographic and other maps.

The element of danger in aerial observation is slight. I am unable to recall an instance of an aviator getting killed while making maps except under war conditions. The fatal accidents come from exhibition flying and the like.

If any man engaged in soil survey work wishes to have a most interesting and instructive experience let him take his field maps into the air and compare them with what he sees on the ground below.

Discussion.

Possibilities of the Aeroplane in Soil Survey Work - W.B.Cobb.

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"I would like to ask Mr. Cobb, when he is flying at say 7,000 feet, if a gust of wind comes and the plane is tilted, how does that affect the mapping?"

Mr. Cobb -

"Of course the map would be out of scale. But the planes used are very steady. Of course it is necessary to have a good pilot who is trained in this particular work and also a photographer who knows his business. The maps are made by flying in strips. The pilot and photographer outline their plan of work and level out a proper altitude by the time they get to the area to be photographed. But if a gust of wind should upset it, of course it would mean a retake. This is only in an experimental stage. The work we did in 1918 was done in a plane which was unsteady. Sometimes a retake is necessary."

Mr. Lapham -

"When you are rechecking, at what altitude do you fly?"

Mr. Cobb -

"It depends on the character of the country. I put it at 9,000 feet."

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"Do you use binoculars?"

Mr. Cobb -

"No, you couldn't use them. It requires pretty good eyesight."

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'Do you have to mark the boundary at the corner of a county?"

Mr. Cobb -

"In flying in Alabama this summer we used a map with red and blue counties and you can see at such a distance that it is easy enough to keep your location, but it requires practice."

COOPERATIVE WORK BETWEEN THE BUREAU OF SOILS AND THE RECLAMATION SERVICE.

By A. T. Strahorn, U. S. Bureau of Soils.

It was not long after the Reclamation Service had begun to supply water to the earlier developed projects that criticism was heard concerning the quality of lands that had been chosen for irrigation, and the same criticism is still expressed more or less fervently throughout the west. In very many instances the critics are simply settlers whose viewpoint extends but little, if any, outside the immediate district in which they live, while in other cases the criticism comes from individuals who have a wide acquaintance with conditions on irrigated lands throughout the west. In some cases there has been every reason to believe that the individual opinions have been promulgated with the idea of embarrassing the Service as much as possible.

That errors have been made in the selections of lands to be irrigated is only too true, but such errors do not altogether account for the large amount of trouble that has been caused by seepage waters and alkali salts. In the majority of cases, the critics have missed the fundamental facts that have brought about such conditions. A discussion of those facts is not strictly in accord with the title of this article, but inasmuch as they are closely connected with the development of irrigation in the West, and are of a direct interest in that they have led to a very firm conviction on the part of engineers, that the soil is of primary importance, it may be worth while to review them briefly.

The facts, which may be grouped roughly under three heads, are: The early personnel and policy of the Reclamation Service; the water supply for the lands; and the general policy of the Water User's Associations toward the distribution of water to the land.

The United States Geological Survey was created by an Act of Congress in 1879, and the investigation of the water resources of the Arid States was made a part of its duties. That branch of the Government Service continued such investigations until the organization of the Reclamation Service in 1902. Since that date, the Geological Survey has confined its water studies largely to the work of stream guaging, leaving the investigation and construction of irrigation and water storage projects to the newer branch of the Service. Consequently, when the Reclamation Service came into existence there was already at hand a vast fund of information regarding water conditions in the Western States, and the Service was able to function as a constructive agency almost from the very first.

The early personnel of the Service was recruited very largely from the engineers of the Geological Survey, as they were about the only men in the country who had any knowledge of the water conditions in the Arid States. In addition to this fact was the pressing demand that the Government construct and operate irrigation projects, and also that there was a large fund in the United States Treasury was immediately available for that purpose. Also, there was at this time, but very little knowledge of the effects of water on land, and that the "realm of Alkali" had scarcely been explored. When we consider that it is but natural for pioneers in a new movement always to attempt a rapid development of the work at hand, and keeping in mind the above mentioned

conditions, it is not a matter for severe criticism that the Reclamation Service did proceed with the development of some projects that have since proven to be not very desirable. To the larger number of engineers in the Service, the soil was important only in that it gave them something to irrigate, and the relations between soil, water, and alkali were apparently unthought of, or were given but the slightest attention.

After a few seasons of irrigation on some of the projects, it became painfully evident that things were not progressing smoothly. Seepage water and alkali were becoming very troublesome. A clearer understanding of how such conditions came to develop with such suddenness may be had by reference to conditions upon both Government and privately owned irrigation projects.

With extremely few exceptions, none of the private irrigation projects were ever able, largely because of financial conditions, to deliver to the land anything like an adequate supply of water for a considerable period after the diversion of the water was undertaken. This condition made a rotation of the available water to the settlers, an imperative practice, with the result that the minimum of water loss in the subsoil, and the development of seepage and excessive alkali conditions was a very slow process. Contrast those conditions with the ones existing upon the Government projects. The financial means were available for the construction of an irrigation system that was able to carry a full head of water to the land from the very first day that the system was put into operation, and as the general policy of the settlers, as expressed through their Associations, has been to demand a continuous flow of water during the irrigation season, every condition has favored a speedy development of excessive amounts of moisture in the subsoil, and of alkali salts at or near the surface of the soil. The whole situation may be stated in a slightly different manner. Given two tracts of land, equal in every respect as to soil, drainage, alkali, and water supply, One tract will be operated by the Government; the other by the settlers, and both begin operations at the same time. After a period of five years, possibly 20 per cent of the settlers project will be receiving only a fairly adequate supply of irrigation water, while the Government canals will be delivering a full head of water to every farm unit that is under cultivation. After another interval of five or ten years, some alkali is possibly beginning to show in a few places on the settlers project, while on the government project it has been found necessary to install drainage systems to reclaim considerable areas of land that have become entirely nonproductive through the development of alkali and a high underground water level. Such conditions are now too well known to admit of argument, but the critics have usually overlooked all of the factors in the situation.

As has been said, the importance of the soil conditions had been overlooked by the greater number of the engineers of the Service, and the matter of recognizing that the fact that soil and water were inseparable was really brought to a focus by some strongly adverse criticism of the conditions upon one of the western projects. That criticism was of a decidedly higher order than the usual news paper publicity, and could not be ignored. The Bureau was requested to make an examination of the project. The conditions on the project were a very good example of an irrigation enterprise designed purely from the standpoints of the storage and distribution of water, and no consideration had been given to the soil conditions beyond that of an estimate that the land would require about four and one-half acre feet of water during the irrigation season. The report of the Bureau indicated generally favorable soils conditions,

but that the estimated duty of water was far too high. Had the construction of this project been preceded by a study of the soil and drainage conditions, the unusually low water holding capacity of the soil would have been considered, and a proper adjustment would have been made between the quantity of water available for storage, and the acreage of land to be brought under irrigation.

The investigation referred to, was made in 1914, and during six of the years that have followed, more or less investigation has been conducted by the Bureau. Up to the present time, work of some kind has been conducted upon seven of the established projects, and upon some 13 or 14 of the "Secondary" projects. "Secondary" is a term used by the Service to designate areas or tracts of land, either virgin or under private irrigation systems, whose possibilities for irrigation are being studied by the Service. At the present time, soil investigations are contemplated upon "Secondary"projects in New Mexico, Arizona, Northern California, Montana, and possibly in Utah and Colorado. The continuation of this co-operative work with the Reclamation Service is somewhat uncertain, depending in part upon the financial condition of the Service, and in part upon the willingness of the Secretary of Agriculture to detail a member of the Department to that work.

The co-operative work with the Service differs from that of the detailed and reconnoissance soil survey work in a number of particulars. The Service is concerned almost solely with the value of the land for continued crop production under methods of irrigation farming, and are not particularly interested in knowing whether the soils have been derived from crystalline igneous or from sedimentary formations. The phrase "value of the land" has no reference to its present or future money value, but it is rather the desirability of the land as measured by the texture and structure of the soil, the topography, drainage conditions, alkali content, and the probable behavior of the land under repeated applications of water. One other feature of immediate interest to the Service, is the net area of irrigable land within the boundary of the project, for the acreage of that area must be sufficient to justify the total construction cost of the project. As the factors that determine the value of the land, and the net irrigable acreage have a direct bearing upon the outcome of a project, they are usually given considerable attention, while some features, as origin and formation of the soils, are not as fully dealt with as in the routine reports of the Bureau.

As the preparation of the map always antedates the writing of the report, some attention may be given to that feature of the work. In an investigation upon a project, the detail to which the soils may be mapped is usually intermediate between that used in a detailed soil survey and that used in a reconnoissance survey. Detail of the mapping will depend largely upon the importance of the soils from the standpoint of alkali and drainage conditions. Since those conditions are so variable, there can be but little rule or precedent for the detail to which the work must be carried, and the field man must develop his map in each case to the detail necessary to bring out the desired information. A soil type may be established that will conform to the specifications of a detailed soil survey type, or a little more latitude may be used and the type may conform to that of a reconnoissance type, or, in extreme cases, the type may be made to include an entire series of soil.

As a rule, it is necessary for the field man to construct a plane table map of the area, and that work is usually carried out on a scale of two miles to the inch. The Service supplies a large size plane table, with a Johnson

adjustable head tripod, and, usually a telescopic alidade. The sizes of the plane tables vary somewhat, but the usual plane table sheet is about 18 by 24 inches. To one accustomed to using the 15 inch Johnson traverse board, this larger sized board seems very cumbersome, but the advantage of a reduced number of plane table sheets, and of a far more satisfactory location control, soon outweigh the awkwardness of the larger board. Distances are measured with a speedometer, and checked as often as possible by the finding of original section corners. The field sheets present much the same appearance as those prepared in the course of the detailed work, but occasionally some special symbols may be used to bring out some desired feature of the work. In addition to the soil map, it is occasionally considered desirable to prepare maps indicating alkali or drainage conditions, maps of watershed areas, or classification maps of various kinds. These may be prepared on the same scale as that used for the soil map, or on some reduced scale, depending upon the importance of the subject, and the use that may be made of the map.

In the early years of the alkali work, it was customary to show the percentages of alkali in the soil by an alkali map, upon which the amount of alkali was expressed by several arbitrary divisions ranging from less than two-tenths of one per cent to more than one per cent. Other grades were occasionally formulated when local conditions could be more clearly brought out by so doing. As the vertical distribution of alkali salts is of fully as much importance as the total amount that may be present in the soil, that condition was often shown by the placing of certain selected rulings upon the map. As time went on, and the limitations of our knowledge of the movements of alkali salts in the soil more evident, it was seen that the mapping of the amount of alkali in the soil by arbitrary grades was not very satisfactory, and the method has been pretty generally abandoned for other systems. In this cooperative work, the present practice is usually to show upon the plane table sheet the location of the boring, its number, the percentage of alkali in each section tested, and the average amount of alkali for the depth of the test. In a great many cases no separate alkali map is prepared, but if one is made the alkali conditions are usually indicated by two or three general grades, such as "alkali free soil", "spotted land", or "excessive alkali".

Alkali tests are made to a depth of six feet, unless prevented by gravel or impenetrable strata in the subsoil, and occasionally to a greater depth. In a western detailed soil survey, an average of one alkali test to every square mile will give a very good idea of the alkali conditions. In this cooperative work, that average is rarely attained, and the usual average is about one test to every two square miles. This does not mean that the tests are distributed with that regularity, for there may be whole townships upon which less than a dozen tests have been made, and in other portions of the area, a single section may carry three or four determinations.

The map that is to accompany the report is usually prepared by the Reclamation Service Draftsmen, and the scale of the finished map is variable. It seems desirable to make the map of such size that it can be conveniently bound in the report, and about 10 by 15 or 16 inches is about the largest size that can be conveniently handled. The process that is now in use for the reproduction of a reduced map permits of very clear and accurate reductions, and a map on a scale of two inches to the mile can usually be reduced to one-sixteenth, or two inches to the mile, with no essential loss in detail.

The report on a project will usually follow pretty closely the outline

given in the Manual of Instructions to Field Parties, although there may not be the same elaboration of each of the subjects given in that outline. In the preparation of these reports, the field man must present the information that is desired by the Reclamation Service. He must also present as much information regarding the physiography of the area, the origin and formation of the soils, as it has been possible to acquire, for the information of the Bureau. These reports are seldom read outside of official circles, for which the field man may at times be truly thankful, for it may happen that many of his statements and conclusions are decidedly adverse to those expressed by the agencies that are attempting to have the Service undertake the development of a project.

The chapter on "Description of the Area" is developed about as it is in the usual soil survey report. The chapter on "Climate" will vary, depending upon the importance of the subject, and the amount of climatological data that is at hand. The chapter on Agriculture is usually given less consideration and in some cases the chapters on climate and agriculture may be combined. The chapter on Soils is usually not so well developed as in the usual report, mainly for the reason that the work is too general to allow of a detailed discussion of the subject.

There is rarely any attempt at a specific correlation of the soils with series that are now recognized by the Bureau, and such correlations are made only when they will serve to identify the soil with one that is already under irrigation upon an established project. In such cases, a statement of the character of the soil series, and its behavior under irrigation elsewhere may be of decided value in forecasting future conditions in the newer project.

You are familiar with the description of a soil type in the usual soil survey report. In this cooperative work, it may be that the discussion of the physical features of the type can be given in a very few lines, but it may also be the case that the structural, textural and topographic features of a type, or of a group, may be such that they are of importance not only within the type, but may also have important bearings upon the alkali and moisture conditions of adjacent soils. It may be necessary to consider such conditions in detail, and to repeat the statements in the discussions of the several types, so as to make the relations of the different soils perfectly clear. An example of such conditions may be cited in the case of certain soils on the western slope of the Rocky Mountains, where the presence of shale, or of relatively impervious clays in the subsoil or substrata, will determine not only the value of that soil for crop production, but may also govern to a large extent the value of adjacent soils of other series. The presence of either the shale or the clay in the subsoil is often not only strongly indicative of alkali and moisture troubles for the type in which they occur, but may also be the direct means by which such troubles may be passed to the neighboring soils through the lateral movement of the underground water. The importance of giving attention to such conditions becomes evident when it is known that the irrigation of such soils has, in a number of instances, resulted in the accumulation of such excessive amounts of alkali and seepage water that the reclamation of the lands are not practicable under the present economic conditions of irrigation farming. Obviously the important feature is to recognize such a condition as being one of the factors limiting the area of irrigable land, and by so doing, an error in the acre construction costs is avoided, and--what is of still more importance--some settler is prevented from attempting to develop a tract of land which will not return him a fair living.

In the usual soil survey report, the topography of the individual types of soil may be indicated by the contours on a topographic quadrangle, and by descriptive matter in the printed part of the report, but it is seldom found necessary to state with exactness the areas of the several types which have a lessened agricultural value because of their unfavorable topography. In the cooperative work, it is often necessary to state, as closely as possible, the acreage of lands that are so irregular that they have no value for irrigation farming, and also the acreage of lands which may possess a rather low value, but which are not entirely worthless. The matter of deciding whether the land is non-irrigable, or of high or of low value, is not entirely a factor of topography, for the matter of local crop adaptation is often a very material factor in arriving at conclusions. In many localities it is profitable to maintain citrus or deciduous orchards upon slopes ranging as high as 30 or 40 per cent, while in a more rigorous climate, where the crop returns must be small, a slope of 10 or 15 per cent may be the maximum slope for irrigable lands. In the above percentages, the figures express the average slope of the land, and the value of such slopes is very often sharply modified by the magnitude of the local inequalities. An average slope of 5 per cent may be so uniform that the land may be prepared for irrigation at but little more than the cost of constructing the necessary ditches, and the same average slope may carry so many hummocks, depressions or shallow drainage courses that the cost of levelling the land would be absolutely prohibitive. In the matter of determining what is irrigable land and what is non-irrigable land from a topographic viewpoint, the field man is occasionally confronted by the activities of a settler to whom the surface inequalities of the land are apparently a minor matter, and who is proceeding with the development of a tract of land that is so rough that there could be not the slightest doubt as to his ultimate failure--and then the chap proceeds to make a success of the job. The ever varying features of the topography, crop adaptation, and the settler are often the contributing causes of gray hairs, and at times about the only rule seems to be to declare land non-irrigable whenever it is so rough that there is more than a reasonable probability of failure for the person who attempts its development--and then take a chance on the settler. Whenever an estimate is made of the areas of irrigable and non-irrigable lands within a proposed project, the question may arise as to the accuracy of the acreages of those classes of land. As a rule, a reclassification seldom makes any material change in the first results. Two men of equal experience may have decidedly different opinions as to the merits of any particular small tract of land, but the total results of their investigations will be found to be in very close agreement. To cite a concrete case--two field men who were strangers and who worked in different years, estimated the irrigable area on a tract of land of about 45,000 acres, and there was a difference of but slightly more than one per cent in the total area of their estimates.

In addition to stating the irrigable area of a type of soil, as governed by its topography, it is also necessary to state the area that is, or which probably will be, adversely affected by detrimental amounts of alkali. It may be that the alkali situation will be of more importance than the physical conditions of the soil, since it may develop upon investigation to be the sole factor that will determine the fate of the project. The discussion of the crop adaptation of the type is very brief, and may even be omitted.

The subjects of Irrigation, Alkali and Drainage may be considered under separate chapter headings, or under but one, depending upon their importance

in the area. These subjects may require considerable space for the presentation of all the facts and conditions. In formulating a statement as to what may develop with the long continued application of water to the land, the field man is confronted by the fact that he really has few rules by which he can be guided. This may sound rather heretical, but when one stops to consider how limited is our knowledge of the movements of under ground moisture, and of the forces that operate to control such movements, it is evident that there are no hard and fast rules that can be applied. The only thing that a field man can do is to draw upon his recollections of developments in other regions and, by allowing for local differences, to arrive at what he hopes will prove to be a correct conclusion.

The usual form of a summary terminates the report.

In the discussion of many of the features of the project, it is often necessary to be rather explicit in the matter of areas, and the field man must often compute such areas with a planimeter. Such data is usually presented in a concise tabulation, and separate portions of the data may be used in the discussions of some of the features of the area.

The report is usually typewritten, maps inserted, and bound in the Denver Office of the Service. The Service retains copies for its use, and forwards copies to the Washington and Berkeley Offices of the Bureau.

At the present time there is an informal arrangement between the Bureau and the Reclamation Service regarding the manner in which the work is to be carried on, and it is hoped that formal and binding agreements can be avoided in the future. At present, the Bureau details one of the field men to the Service, and his salary and expenses are met by the Bureau appropriations. The Reclamation Service furnishes the necessary instruments and supplies, such as plane tables, alidades, drafting materials, etc., provides transportation within the area, pays the wages and expenses of such assistants as may be needed, reproduces the maps, and typewrites and binds the reports.

During the season of 1922, the average rate of field work was about six square miles per working day, and that rate is probably not far from the average.

In addition to the investigation of "Secondary" Projects, the services of a man from the Bureau are occasionally requested for work of one kind or another upon established projects. The questions that arise for settlement upon the older projects are local, and a detailed consideration of the work would involve a discussion of the conditions that exist upon each of the projects. The majority of the work, however, is concerned with some phase of alkali and underground water difficulties. Such conditions may be of even more importance than they are in virgin areas, as the necessity may arise of determining whether it will be profitable to reclaim land and restore it to its former state of productiveness. It has occasionally happened that there has been no recourse (with our present knowledge of soils and alkali) but to recommend the elimination of the land, but as the loss of land from the project imposes a heavier burden upon the farmers, every effort is made to retain it if there seems to be any hope of ultimate utilization.

In conclusion, it may be permissible to recount some two or three of the

unsolved problems relating to alkali and underground waters. We know very little regarding the tolerance of our cultivated crops toward the alkali, in the soil, and this problem seemingly presents an almost endless task for the scientist. We have gathered a few hints from the native vegetation as to the alkali and moisture conditions of virgin soils, but our knowledge of the subject is so limited that we find apparent contradictions on every hand. To be able to state, with a considerable degree of certainty, that a plant indicated certain things would be of enormous benefit in understanding the conditions in uncultivated soils. There are almost endless questions arising regarding the movement of alkali in soils, and conditions are constantly arising for which we have no answer. The movement of the subsoil waters is also a matter of almost absolute darkness, so far as any real knowledge is concerned, and if we could oftentimes only get a hint as to what was governing the movement of the water, it would mean very large savings in the matter of drainage, and would give us a far more satisfactory knowledge of the movements of alkali salts.

BULLETIN IV VOLUME II

REPORT OF THE THIRD ANNUAL MEETING

OF

THE AMERICAN ASSOCIATION OF SOIL SURVEY WORKERS

HELD IN

UNION BUILDING, UNIVERSITY OF ILLINOIS

URBANA, ILLINOIS

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Report of the Committee on Soil Color Standards.

J. Gladden Hutton, In Charge of South Dakota Soil Survey.

The Committee on Soil Color Standards was invited by Dr. Whitney, Chief of the Bureau of Soils, to meet in Washington and to make use of the soil collection of the Bureau. The first meeting occurred March 28, 1922, and the sessions continued for five days.

In the report of this Committee at the Lansing meeting last November it was suggested that if standard color disks were available it would be possible to duplicate any given soil color and to record the color factors involved in such duplication. However, the Bureau of Standards has not selected colors of a standard value which may be used. A beginning has been made in the criticism of the color systems of Ridgway and Munsell and in connection with the Munsell Company work has been started in the direction of the standardization of colors.

The Committee had hoped to be able to get a set of standard colors printed in a convenient form for field use. One of the principal engraving companies which has done much fine color work had the matter under consideration, but just before the meeting of the Committee declined to attempt the work. Another company had expressed a willingness to undertake the printing of a set of colors based on a color system that will meet the requirements of the Bureau of Standards. This company, however, is not yet ready to bring out its system. The Committee, therefore, temporarily laid aside the plan of getting colors printed. The plan of producing colors by whirling Maxwell disks, as proposed by the chairman, was also temporarily abandoned for the reason that no standard disks are available.

The Committee was then left with the problem of providing a temporary set of samples to be used by field men. From the thousands of samples in the collection of the Bureau of Soils about 300 were selected which included almost every distinct soil color. From these about 80 were finally selected as sufficient to cover the range of common soil colors. In order that it might be possible to refer these colors to some standard, Ridgway's "Color Standards and Color Nomenclature" was to be used as a reference and all colors selected have been compared with the Ridgway colors and the Ridgway color-name and number have been attached.

In Table No. 1 the names of the common soil colors as usually understood appear in the first column; the collection numbers appear in the second column; while Ridgway's numbers and color names are found in the third and fourth columns respectively.

The colors listed in Table No. 1 were arranged into 32 groups, as indicated, and from each of these groups one sample was taken which in the opinion of the Committee was most representative, and it was usually the mean or average color of the group. These groupings and selections were made separately by members of the Committee as well as by other soil surveyors who

were called in, so that they do not represent the ideas of any one individual.

The Committee planned to prepare sets in small bottles for field use. When the plan was presented to Dr. Whitney by Mr. Rice after the Committee adjourned, he suggested that an experiment should be made of pressing the samples into small briquettes. The Bureau of Soils had a press which could exert a pressure of 2,500 pounds to the square inch, and could by slight modification be adapted to this purpose. From a mechanical standpoint the experiment was a success. With the exception of pure, or almost pure, sands and silts, soils may be made into briquettes which will withstand ordinary usage. Even the sands may be made into briquettes by supplying a filler of clay or other cementing material. A slight change of color or shade is brought about by pressing the sample resulting, as a rule, in a somewhat darker or duller color. This can be provided for by choosing brighter colors in order to get the desired shade after compression. After the proper colors are secured a sufficient number of sets may be made up to supply field men. The change in colors on compression are indicated in Table No. 3, Mr. Rice having made the comparisons with the original samples.

If the briquettes are protected by Riker mounts like the one exhibited and care is taken in selecting clear white glass for the cover, much of the color comparison work may be done without exposing the briquettes. In some cases it may be necessary to remove the glass for satisfactory comparison.

It is true that the selection of colors by the method followed by the Committee is somewhat arbitrary and unscientific, but owing to the present status of the color standard problem, no better method seemed available. An attempt has been made to select a set of colors for use in the field which would bring about greater uniformity than we have in soil color descriptions at the present time. No doubt there will be a demand for a more extensive list. The proposed list can, of course, be enlarged by adding intermediate colors.

The color names used are also somewhat arbitrary and are somewhat of a compromise between the common name and the true color as designated by Ridgway. However, the Ridgway equivalent has been recorded in each case so that the proposed color system may be compared with any standard color system which may be evolved.

The Committee has tried to avoid such commonly misused terms as drab, chocolate, etc.

The present report should be regarded as tentative.

Respectfully submitted,

J. Gladden Hutton, Chairman
Thomas D. Rice
A. M. O'Neal.

Table No. 1.

Soil Colors Selected from the Collection of the Bureau of Soils, U. S. Department of Agriculture.

(Colors marked "#" have been selected and samples prepared for field use)
(See Table No. 2.)

Soil Color	Soil No.	Ridgway's No.	Ridgway's Color
# White	261918	None	White
# Grayish white	16493	None	None
Light gray	28377	17""d	Drab gray
# Light gray	322911	21"'d	Olive buff
# Gray	332310	17""d	Drab gray
Gray	14224	17""b	Light drab
Dark Gray	28383	21""d	Smoke gray
# Dark gray	28387	15""'	Mouse gray
Dark gray	372830	17""i	Hair brown
Cream color	422410	21"f	Ivory yellow
Cream color	24345	19"f	Cartridge buff
# Light grayish yellow	234021	19'f	Cream color
# Light grayish yellow	234622	19"d	Cream buff
Light grayish yellow	211507	17'd	Warm buff
Yellow	24346	17f	Pale orange yellow
# Yellow	415322	19"h	Chamois
# Orange	28575	15'i	Ochraceous tawny
# Yellowish brown	181918	17"i	Tawny olive
Yellowish brown	25068	17"b	Cinnamon-buff
Brown	190317	17"i	Tawny olive
Brown	29092	19"i	Isabella color
Brown	130217	17"'i	Buffy brown
Light reddish brown	422110	17"	Cinnamon
Light reddish brown	414424	17"i	Sayal brown
# Light reddish brown	421936	15"	Cinnamon
# Reddish brown	201029	17"'b	Avellaneous
Reddish brown	242451	17"i	Tawny olive
# Reddish brown	423613	15"i	Sayal brown

Table No. 1 (Cont.)

Soil Color	Soil No.	Ridgway's No.	Ridgway's Color
# Reddish brown	253276	13'i	Tawny
Reddish brown	254601	17k	Antique brown
Dark brown	5509115	15"k	Snuff brown
# Dark brown	5509114	17"k	Saccardo's umber
Dark brown	550903	17"'i	Buffy brown
Dark grayish brown	28712	17"'i	Buffy brown
# Dark grayish brown	28666	17""	Drab
Dark grayish brown	371025	17""	Drab
Dark grayish brown	332180	17""	Drab
Dark grayish brown	28687	17""	Drab
Very dark grayish brown	28639	17""i	Hair brown
Very dark grayish brown	28679	13""k	Fuscous
Very dark brown	444981	15"m	Bister
Very dark brown	372001	17"'k	Olive brown
# Very dark brown	444905	17"k	Saccardo's umber
Very dark brown	22408	13""k	Fuscous
Black	261362	9""k	Dusky drab
Black	333743	15""'i	Deep mouse gray
# Black	331829	13""m	Fuscous black
# Olive gray	351794	21"'	Dark olive buff
Olive gray	170564	21""	Grayish olive
Dark olive gray	22379	21""b	Light grayish olive
# Dark olive gray	22412	21""	Grayish olive
Mouse gray	370716	21""i	Deep grayish olive
# Mouse gray	321022	15""'i	Deep mouse gray
# Yellow olive	16998	19"i	Isabella color
Yellow olive	170563	19'i	Old gold
Dark olive drab	170546	21"i	Ecru olive
# Dark olive drab	170478	21"k	Buffy olive
Green	170547	25"k	Kronberg's green
# Light reddish yellow	414337	17"b	Cinnamon buff
Yellowish red	414338	15"b	Pinkish cinnamon
# Yellowish red	235504	11'b	Apricot buff
Red	416118	11'i	Cinnamon-rufous
# Red	22953	11'i	Cinnamon-rufous

Table No. 1 (Cont.)

Soil Color	Soil No.	Ridgway's No.	Ridgway's Color
Deep red	12697	9'i	Ferruginous
# Deep red	255712	11k	Sanford's brown
Deep red	44--Tex.	9k	Burnt sienna
Dark red	16328	9k	Burnt sienna
# Dark red	16327	11'k	Hazel
# Dark brownish red	255523	11m	Auburn
Purplish brown	312518	13"'	Fawn color
Purplish brown	312517	17"'i	Buffy brown
# Purplish brown	4446127	13""	Drab
Purplish brown	444695	13""	Drab
Purplish brown	4446123	15'k	Cinnamon-brown
Grayish purple	22199	13"'	Fawn color
# Grayish purple	211723	13"'	Fawn color
# Purplish red	211724	9"i	Cacao brown
Purplish red	22429	13"i	Mikado brown
Purplish red	22428	13'm	Mars brown

Table No. 2.

List of Thirty-Two Soils Selected for Use in the Field.

Selected color No.	Soil No.	Usual Group Name. (Arbitrary)	Ridgway's Color Name	Ridgway's Number.
1.	261918	White	White	None
2.	16493	Grayish white	Grayish white	None
3.	322911	Light gray	Olive buff	21"'d
4.	332310	Gray	Drab gray	17""d
5.	28387	Dark gray	Mouse gray	15""'
6.	234021	Light grayish yellow	Cream color	19'f
7.	234622	Light grayish yellow	Cream buff	19"d
8.	415322	Yellow	Chamois	19"h
9.	28575?	Orange?	Ochraceous tawny	15'i
10.	181918	Yellowish brown	Tawny olive	17"i
11.	201029	Reddish brown	Avellaneous	17"'b
12.	421936	Light reddish brown	Cinnamon	15"
13.	423613	Reddish brown	Sayal brown	15"i
14.	5509114	Dark brown	Saccardo's umber	17"k
15.	28666	Dark grayish brown	Drab	17""
16.	444905	Very dark brown	Saccardo's umber	17"k
17.	28679	Verk dark grayish brown	Fuscous	13""k
18.	331829	Black	Fuscous black	13""m
19.	351794	Olive gray	Dark olive buff	21"'
20.	22412	Darkoolive gray	Grayish olive	21""
21.	321022	Mouse gray	Deep mouse gray	15"" 'i
22.	16998	Yellowish olive	Isabella color	19"i
23.	170478	Dark olive drab	Buffy olive	21"k
24.	414337	Light reddish yellow	Cinnamon buff	17"b
25.	235504	Yellowish red	Apricot buff	11'b
26.	22953	Red	Cinnamon rufous	11'i
27.	255712	Deep red	Sanford brown	11k
28.	16327	Dark red	Hazel	11'k
29.	255523	Dark brownish red	Auburn	11m
30.	444695	Purplish brown	Cinnamon drab	13""
31.	211723	Grayish purple	Fawn color	13"'
32.	211724	Purplish red	Cacoa brown	9"i

Table No. 3.

Effect of Briquetting on Color of Sample.

Color No.	Soil Collection Number	Color of Loose sample	Color of Briquette.
1.	261913	White	White
2.	16493	Grayish white	Grayish white
3.	322911	Olive buff	Smoke gray?
4.	332310	Drab gray	Drab gray
5.	28387	Mouse gray	Mouse gray
6.	234021	Cream color	Cartridge buff
7.	234622	Cream buff	Cream buff?
8.	415322	Chamois	Chamois
9.			Ochraceous tawny
10.	181918	Tawny Olive	Tawny Olive
11.	201029		Avellaneous
12.	421936	Cinnamon	Cinnamon?
13.	423613	Sayal Brown	Cinnamon-Sayal Brown
14.	5509114	Saccardo's umber	Buffy Brown-Saccardo's Umber
15.	28666	Drab?	Drab
16.	444905	Saccardo's umber	Sepia
17.	28679	Fuscous	Hair brown
18.	331829	Fuscous Black?	Chaetura Black
19.	351794		Light Grayish Olive
20.	22412	Grayish olive?	Grayish olive
21.	321022		Mouse gray
22.	16998	Isabella color	Isabella color
23.	170478	Buffy olive	Grayish olive
24.	414337	Cinnamon buff	Cinnamon buff
25.	235504	Apricot buff	Orange cinnamon
26.	22953	Cinnamon Rufous	Cinnamon Rufous
27.	255712	Sanford Brown	Hazel
28.	16327	Hazel	Auburn
29.	255523	Auburn?	Mars brown
30.	444695	Verona brown?	Natal brown
31.	211723	Fawn color	Wood brown
32.	211724		Fawn color

In the foregoing table the soil color number is given, then the collection number of the sample. Column No. 3 gives the Ridgway color-name determined in the loose sample; Column No. 4 gives the Ridgway color-name as determined from the compressed soil of the color-standard briquettes.

THE NEED OF COLOR STANDARDS FOR USE IN THE FIELD.

A. M. O'Neal, Iowa Soil Survey.

The present system of soil classification depends largely upon color. The official series descriptions furnished by the U. S. Bureau of Soils gives the colors and color limits of the various soil horizons and these in turn must be interpreted and applied by the field men. The task is rendered all the more difficult since soil conditions are variable. The moisture content which has a decided effect upon soil color is subject to wide fluctuations. Therefore it is doubtful whether the different field men will have the same conception of a given series description or whether the same man can consistently hold a given type within given limits during a season or from season to season.

Realizing these difficulties, work was started to see if the present system could not be improved to meet the demands. These investigations have not been carried far enough to justify any definite recommendation. It is deemed advisable, however, to outline the present scheme in hopes that it will stimulate interest and open up new lines of thought.

The soil colors picked out by the color committee to serve as a nucleus around which to build all future work are excellent. Still in their present form they are of little value to the field men. They require a set of color standards fixing the color limits of the various series. These standards should give both the color terminology and the actual colors of each horizon. The air dry sample would be ideal for comparison but soils are scarcely ever observed in this condition in the field. Since such is the case it would seem advisable to show the 3-foot soil section in an air dry condition and with 10, 20, and 30 per cent of moisture. The field man could then estimate the amount of moisture and by comparing with his table easily classify his soils. It should be much easier and more accurate to determine the moisture content than to estimate what color a soil containing say 20 per cent of moisture would be if in an air dry condition. The latter leaves too much to the imagination. The chance of error is much greater.

The character of the soil work requires that such a set of standards be compact and easy to carry at all times. Something small that can be slipped into the pocket. Vials of soil are excellent for use in the room but too bulky to handle. The reproduction of the 3-foot soil section in oils or water colors would prove most valuable. This would enable the standards to be prepared in the form of a small loose leaf book, say 3 inches by 6 inches. Each leaf could be devoted to a series giving not only the official series description but small plates showing the actual colors of the soil horizons in an air dry condition and with 10, 20, and 30 per cent of moisture. In this way only the series required at any time need be carried. The chief objection to this scheme is the reproduction of soil colors. However it is felt that this difficulty will soon be overcome. In fact it is not unreasonable to believe that the required soil colors could be reproduced at the present time by some artist.

REPORT OF THE COMMITTEE ON PUBLICITY AND INFORMATION

By P. E. Brown, Iowa State College.

The problem of securing the right kind of publicity and disseminating desirable information regarding the soil survey is one which confronts every state which is carrying on that work. Conditions vary so widely in the different states that the same methods of solving the problem are not applicable in all cases. Available facilities must be utilized, whatever they may happen to be and the methods followed must meet the exigencies of the local situation. Hence it is impossible to lay down any hard and fast rules regarding publicity and only more or less general suggestions can be offered.

This committee is not prepared to present any new or startling aspects of the publicity problem, and may not suggest anything which will be of any practical service. If the report serves, however, to stimulate some thought and discussion along these lines, our object will have been accomplished. Perhaps a chance word may give someone a new idea which will be of interest. Perhaps our discussion may serve merely to crystallize the ideas in some of our minds. Perhaps we shall have only an exchange of opinions and policies. But in any case, we may all benefit to a certain extent, by learning of experiences elsewhere, by viewing the problem from different angles and by considering briefly the merits of the various publicity methods which are in vogue.

THE NEED

In the first place it may be well to consider why any publicity is necessary. It is a sad but true fact that the real reason for a publicity program in most states is because of the necessity of securing appropriations for the work. Only one state with which we have had correspondence reported that no publicity was needed because no special appropriations were secured. Most of us have to consider constantly how to secure public approval of our work so that our State legislatures may generously permit us to continue our efforts to be of service to the Agriculture of the State.

But after all, I am inclined to believe that the necessity for publicity, whatever its source, is not an unmitigated evil by any means. In fact in our efforts to secure support for our work we are obliged to popularize it. This is manifestly desirable. It is necessary to explain it, to show how the maps may be of service and to use every effort to bring the results to the attention and use of the farmers. When we do this, we "kill two birds with one stone" as it were, for we secure the favorable attention of the public which militates in our favor with the state legislatures and we also accomplish the chief object of the soil survey--the betterment of crop production through a knowledge of soils and their needs.

We may conclude, therefore, that proper publicity is really very desirable in all soil survey work even if not "financially" necessary in order that the purpose of the work as ultimately contemplated, may be more quickly and more generally accomplished.

There need be no less scientific value to the results secured because of the popular presentation of such parts of the work as will bear popularization. Soil Science, in the long run, will gain rather than lose by practical tests of the fundamental facts which are constantly being uncovered in the soil survey. The portion of the work which may be used popularly must, however, be chosen carefully and this presents a problem which will be mentioned later.

THE AMOUNT

Assuming then the need for publicity, the next question which arises, pertains to the amount of such publicity. One of our correspondents believes that we have reached the stage where a great whirlwind campaign of publicity would not be to the best interest of the work. This is undoubtedly true for several reasons. The most important of these is that too much publicity would be an actual detriment to the work because it would lead to greater demands upon us than we could meet. I refer not to the amount of work but rather to the practical conclusions and recommendations drawn from the work. Over-enthusiastic editors and feature story writers often actually harm their cause because they lead the public to expect too much. We must be careful in the soil survey that we make no claims that we cannot back up, otherwise we may bring discredit upon the whole project.

Our conclusions in regard to the amount of advertising may be summed up in the word "judicious"--a very much overworked, often improperly interpreted word--but one, nevertheless, which alone expresses the thought here.

THE PLAN

The plan to be followed in securing publicity and providing information should be carefully worked out. In how many of our states is there a definite plan? Our correspondence does not answer this question, but reading between the lines, it would seem that in practically all cases the plan is merely to publish something occasionally when "the spirit moves us" and to speak on the survey when the opportunity presents itself. Too often we spend much time wondering why on earth the farmers in our states are not progressive enough to know all about the survey, while we do not follow any systematic plan of telling them about it.

A definite plan for publicity will solve many of our difficulties, and we believe that it is almost as important to have a well planned out program for publicity and information as it is to have the very complete and comprehensive outlines for the actual soil survey work, which are required of all of us. Haphazard, chance publicity will not bring results any more than "hit or miss," reconnaissance mapping will give us accurate maps.

Just what plan should be followed cannot be suggested as conditions will of necessity determine that. The actual plan is really of secondary consideration. The main thing that we would urge is to have a plan and to follow it as closely as possible. Every member of the staff should not feel free to send out news items as he sees fit--the policy of the department should be fixed so that some one or two men see that only proper material is submitted for publication. This does not mean that all should not aid in the publicity work but merely that it should be safeguarded from improper, often unintentionally unwarranted statements. If the plan for publicity calls for a short article each month in the college news letter, different men may prepare the material but if one man is responsible for the editing then there is absolutely no danger of having to issue apologies and corrections. From our own experience, I would say that if you keep something coming in regularly to the College News Letter, you will avoid having the Editor of that Letter take the liberty of making up a story about your work which may cause you some difficulties.

Again if your plan provides for meetings in charge of extension men, these men should be able to give full information on the survey and your plan should prescribe rather definitely just what information and statements they should give out. Too often these meetings do not aid the survey as they might because the men holding them know too little about the survey or take the opportunity to set forth views of their own rather than the teachings of the college and station. Truly for soils extension men, as Prof. Miller told you last year, we need men who have had some soil survey experience and therefore have the proper viewpoint.

These few remarks will serve to show that we would urge that a plan or project for publicity be worked out in some detail in order that the best results may be secured.

THE METHODS

The methods which may be followed in carrying out the publicity and information campaign must receive most careful consideration. The committee report last year set forth the ways and means employed in the states and we can only repeat and emphasize some of the suggestions made then:

Many are agreed that the state report on the soil survey of a county, containing not only the map, laboratory, greenhouse and field experimental results but also practical recommendations regarding soil treatment provides one of the most desirable means of publicity and information.

The use of the pamphlet prepared by the Association on "The Value of the Soil Survey" is proving of value in some states to attract interest to the work. Periodic news letters pertaining to the progress of the work in individual counties and in completed areas are recommended. Publications of articles from time to time in the College News Letters, and in the state papers is always desirable under the restrictions mentioned above. Special circulars and bulletins on the work will be very desirable in many cases.

The field experiment work on individual soil types should undoubtedly be made an integral part of the soil survey program and the results from these tests will prove of large value in publicity work.

Meetings of various kinds are suggested in different states. The Extension Workers are depended upon primarily for these meetings and these men may hold special soil survey meetings in surveyed counties with very satisfactory results. Talks before local Farm Bureaus, County Agents, Real Estate Associations, Short Courses and any general meetings of farmers should be given whenever possible.

Some work on the soil survey methods and discussions of its value and use should certainly be given to the students in our agricultural courses in the colleges and carefully selected work may also be of value in high schools and even in grade schools where agriculture is taught.

Demonstration meetings on experiment fields are of much interest and always attract favorable comment. Special demonstration fields may be laid out by the Extension men or the County Agent and in surveyed counties they will prove of especially large value.

The soil surveyor is not free from all responsibility in this publicity work for he has considerable contact with the farmers in his work and may do much to aid in creating a favorable impression regarding the work. One state provides the men with cards setting forth the purpose, plan and value of the soil survey and these cards are distributed to farmers. The surveyor, however, should always feel the necessity of talking with interested farmers and giving them information regarding the work even if it interferes to some extent with their work. Too much time spent with farmers will, of course, delay the mapping and the field men must exercise judgment in this matter.

It is apparent that a wide variety of methods may be employed in publicity work and the selection of methods must be based upon several factors such as the local demands, facilities available, personnel, funds which may be utilized, and material which is suitable for use. It is particularly important that close attention be given to whatever methods are followed in order to observe their efficiency. Changes or modifications may be needed constantly in order to secure the best results.

THE MATERIAL

Finally we may mention briefly the material which may be utilized in publicity work. General informational statements on the purpose, nature and value of the survey are of special value in areas to be surveyed or in states just taking up the work. Popular reports on the progress of the work in areas being surveyed are timely and very desirable. Circulars of bulletins by the Station carry worth while information to the general public and may prove valuable. The material employed in all these statements or publications is necessarily of a very general nature and popular in character.

The state reports should also be popular in nature and should include besides the map and thorough descriptions of all soil types and their needs, the results of chemical or other laboratory analyses and the data secured in greenhouse and field experiments. They will then prove of the most interest to the farmers and agricultural public in general. Further the reports and maps will provide the essential material for soil survey meetings held in surveyed counties. Other material may of course be used in these meetings as it happens to be available but the maps and reports are absolutely necessary.

The experiment fields provide abundance of material for field meetings and demonstrations and the results secured from them are of use for all other soil meetings, for general lectures, for news items, feature articles and special reports.

Exhibits at fairs and at shows of different kinds demand a special sort of material and much ingenuity is necessary to prepare and put on an exhibit. There is much that may be used from the soil survey but our experience is that the soil map and the field experiment results are the most popular and they never seem to lose their interest.

In general it may be said that any of the results of the soil survey work which are capable of popular presentation may serve for publicity material. Again, however, it should be emphasized that the use of the material should be "judicious" and according to a well-defined plan.

I n conclusion, we would merely repeat that good publicity for the soil survey is not only of value in the securing of appropriations but is really fundamental to the accomplishing of the real purposes of the work.

Our problem then is to outline a definite publicity campaign, select the methods carefully, choose the most suitable material, and see that the amount of publicity is judicious. Only in this way can the desired results be secured.

Committee on Information and Publicity,
P. E. Brown
C. P. Shaw
W. E. Hearn

REPORT OF THE COMMITTEE ON IMPROVEMENT OF SOIL MAPS AND REPORTS

By, W. J. Geib, Wisconsin Cooperative Soil Survey.

The Steering Committee which was appointed at the last annual meeting of the Association recommended that the Chairman of this committee be authorized by the Bureau to spend some time in a well known lithographic plant for the purpose of becoming thoroughly familiar with the making of maps and to learn as much as possible about map construction from the inside so that this information could be of use to the Association and its members in the improvement of soil maps. Inasmuch as the Bureau did not authorize the Chairman to make this special study we have nothing to report on that particular phase of the work.

As a member of the Committee, Professor Krusekopf is to give an address at this meeting on the improvement of soil reports, we shall not take time to go into that phase of the question in this report. The Committee, as such, has held no meetings and we have had but little correspondence.

The improvements in soil maps to which I wish to direct your attention at this time, are those which are being attempted by the co-operative Soil Survey in Wisconsin. At the last annual meeting we exhibited before the Association a proof copy of the revised map of Outagamie County, Wisconsin. This map has finally been printed and a State edition of the report together with this map will soon be ready for distribution. A copy of this map is placed on exhibition for your inspection. It will be noted that the improved Legend which the map has is on the side instead of at the bottom. This became necessary on account of certain lithographic difficulties and not because of our desire to have the Legend on the side.

Our Jackson County map has been modified along the same lines and we are placing before you a copy of the map of Jackson County, Wisconsin which you will note has this revised legend at the bottom of the map in the space which was previously blank. On the Jackson map the new legend has required no extra space and the additional cost for 3,500 copies was only $75.

Our purpose or the main object in revising the legend is to make the soil map tell a complete story by itself and also to prepare it in such a way that it will be suitable as a wall map, which will permit it to be used in schools, banks and numerous other places.

It will be noted by inspecting this map that the various soil types have been arranged in textural groups and that the revised legend has been divided into five separate parts. The first part gives the "Name of the Soil", such as Superior clay loam. The second part gives a "description of the Soil and Subsoil" and for this particular type reads "Brown clay loam on heavy compact red clay." The third division gives the "Surface features and drainage," and for this type we quote the information that the soil is "level to undulating, surface drainage fair, under drainage slow." The fourth division gives "Uses and adaptation" of the soil and for this type we have the following, "Small grain, clover and timothy, grazing silage,

peas and sugar beets. Good dairy and general farming land." In the fifth division we have "Fertility and methods of improvement." Under this heading we find "Seldom acid, somewhat deficient in organic matter and phosphorus. Green manuring important. Acid, phosphate or mixed fertilizer may be used to supplement the stable manure. Good rotation consists of clover and timothy, corn for silage, and small grain. Tile drains are profitable on most of the level land."

By having the soils in textural groups it will be seen that some of these descriptions in the various divisions will apply to more than one type. By this group arrangement we can thus save considerable repetition.

Work is now being carried forward on the revision of the soil map of Kenosha and Racine Counties and it is proposed to have a legend of this kind for that map also. One additional feature which is being introduced is in the first division of the legend. We are suggesting that the acreage of each soil be given under the color block so that by inspecting the legend one can readily determine the importance and actual extent of each type of soil.

We might call attention to another change which is being made in the map of Racine and Kenosha Counties of Wisconsin. In this area which covers two counties the work in the field outlined for example, Clyde soils, Maumee soils and Newton soils, all of which are retained on the Bureau's map. The soils are black, poorly drained lands and in the heavier members of the series the soil sections extend to a depth of over three feet before a lighter material is found. In order that the map may be simplified it is proposed now that these three series, when the type will permit, all be correlated as Clyde soils. They appear to have practically the same agricultural value, and all require drainage before they can be farmed successfully. The degree of drainage needed is practically the same in all cases, or at least the variation between series is no greater than the variation in the series. By making this correlation the number of types is reduced somewhat and the map is simplified. It also does away with the introducing new type names for soils which were previously mapped under old established type names.

I trust that those who are interested in the improvement of maps. will carefully inspect the exhibition here shown and make constructive criticisms and suggestions. We feel that some improvement has been made in the legend but there are doubtless many other respects in which the legend and maps may be changed to advantage.

Committee on Improvement in Soil Maps and Reports.
W. J. Geib
H. H. Krusekopf
J. O. Veatch.

THE IMPROVEMENT OF SOIL SURVEY REPORTS.

By J. O. Veatch[1].

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[1] Member of the Committee on the Improvement of Soil Survey Reports.

The Soil Survey report, as an ideal scientific publication, should be concerned primarily with soil classification and the description of soils per se. However, at present for a number of reasons, it is expedient to include a measure of agronomy and other extraneous matter bearing upon agriculture.

The following arrangement and order of the subject matter of the report is suggested, each subject to form a center heading.

1. Geography of the Area
2. Soils
3. Description of Soil Types
4. Agriculture
5. Climate

It is believed that side headings would simplify and make the report more readable for all classes of readers. Under Geography of the Area, the following suggestions are offered.

Location and Area.--Restricted to a statement of the position of the area within the State and to its size in square miles and acres. Mention of latitude and details of boundaries, shape and dimensions are relatively trivial.

Topography.--A brief, concise description presenting the information of most significance in relation to soil classification and agriculture; a presentation of the topographic aspect by employing the descriptive terms in common use such as level, rolling, mountainous, etc; elevation above sea-level and local differences in elevation; drainage--as determined by gradient of slopes and perviousness or imperviousness of substrata. The names and descriptions of the courses of streams in the area are obvious from an inspection of the soil map and add nothing of value in text of the report. A sketch map showing the topographic divisions in those areas which possess contrasts in topography and well marked divisions, would be a valuable addition to the soil survey report.

Native Vegetation.--A mention of the original plant formations and associations would have a purely scientific value in soil studies and would have a practical bearing on agricultural development in those areas containing large amounts of virgin land.

Water Supply.--From the purely agricultural point of view, a paragraph on the source and quality of the water supply for domestic and general farm purposes is recommended.

Industry and Natural Resources.--Brief mention of industries and principal natural resources--confined to one or two paragraphs. Details of the nationality of the early settlers and the present population; towns and their population; highways; railroads; and telephones is information usually sent out by chambers of commerce and other advertising agencies and might be omitted without affecting the value of the report. Possibly the mental energy of the writer could be employed to greater advantage on parts of the report of a more technical nature.

In the chapter on Soils the following treatment is suggested.

1. Introductory paragraph in which the outstanding soil characteristics of the area as a whole are mentioned.
2. A brief description of the generalized profile of the soil developed: (1) under conditions of good drainage; (2) under conditions of poor drainage. The lithologic nature of soils which are equivalent to geologic formations as recent alluvium, beach deposits, etc.
3. Basis of classification of soils for purposes of mapping. The distinguishing intrinsic characteristics of each subgroup or series, without reference to its geologic or topographic relations.
4. Evaluation of geology, topography, native vegetation and age as modifying and determining factors. Basically the soil is a function of conditions of moisture and temperature which have obtained over great periods of time.

It is believed that the newer conception of soil classification should be adopted. In this, the grouping of soils is based upon the recognition of the complete soil profile, without limitation as to thickness, and the peculiarities and arrangement of its separate parts or horizons. Mappable units are established on the basis of intrinsic peculiarities, both physical and chemical, independently of topography and geology.

Description of Soil Types.

In the technical description of the soil type, clearness and conciseness are more important than in any other part of the report. A description of each horizon or separate part of the complete profile beginning at the surface and listing each by number or name, would greatly aid the reader in visualizing the soil.

It is recommended that color and other differences between the virgin soil and the cultivated soil be brought out; likewise the differences traceable to different amounts of moisture in the soil.

Laboratory data, both chemical analyses and physical determinations, when available should be included, but should be frankly interpreted.

A mention of the range in physical and chemical character allowed in mapping and a detailed mention of the location and occurrence of inclusions

of other types, should be incorporated in the description of the soil type. The soil map leaves the impression, that the area covered by some one color or pattern is uniform in soil--which may not be true because of the scale of mapping employed or due to an attempt to draw too fine textural distinctions.

Statements of the selling price of land have only a transient value at best and might be omitted.

Agriculture.

The chapter on agriculture should be greatly abbreviated, since from the title, the report is ostensibly a soil survey--not a survey of agricultural conditions--and should therefore be restricted as far as practicable to the description of soils and the science of pedology. Greater attention given to bringing out the relations of the distribution and yields of crops and farm methods to soil types would be a distinctive improvement.

Climate.

It is believed that a fuller interpretation in relation to agriculture of the climatic data presented would make the report have a higher value. Additional weather bureau data upon frequency and duration of droughts; evaporation; percentage of clear days or amount of sunshine; frequency of hail storms, depth and duration of the snow cover would add to the value of the report from the agronomic point of view.

Summary.

The summary as at present written does not enhance the literary value of the report, and because of the nature and brevity of the average report, it is questionable whether a summary is needed at all.

REPORT OF THE COMMITTEE ON CORRELATIVE LABORATORY WORK.

By G. W. Conrey, Chairman.

As a basis for making suggestions for the development and expansion of laboratory work as a part of the Soil Survey, exact information concerning the nature of laboratory work under way is desirable. To this end inquiry has been made of the various organizations engaged in Soil Survey work. In order to systematize the information answers were requested to the following questions:

1. What laboratory work is being done in connection with the Soil Survey in your State? List determinations being made, either chemical, physical or physico-chemical. If "availability" or solubility determinations are being made in connection with chemical analysis of soils, indicate the elements so determined, and the general method employed, as N/5 HNO_3 digestion, etc. Distinguish between laboratory work connected with the Soil Survey and distinctly research projects of the Station.

2. What additional determinations of either a chemical, physical, or physico-chemical nature might be made to advantage in connection with Soil Survey Work.

These questions have been addressed to forty states or organizations, including the Bureau of Soils and four Canadian Provinces. Laboratory work has been reported by twenty-eight of this number. The following report is very largely a summary of the data secured from these replies.

A. Laboratory work being carried on by the various States engaged in the Soil Survey.

Number of States reporting laboratory work--28.

1. Chemical.

a.	Complete analysis	1	(Bureau of Soils) (3)
b.	Total analysis		
	Phosphorus	21	
	Potassium	17	
	Nitrogen	23	
	Calcium	13	
	Magnesium	10	
	Sulphur	6	
	Inorganic carbon	9	
	Organic carbon	12	
d.	Lime requirement or reaction	17	

c.	Solubility determinations.	
	N/5 HNO_3	4
	Phosphorus	4
	Potassium	4
	Calcium	1
Strong HCl		1
Water soluble salts		6
Water CO_2		1

Methods. Veitch
Hopkins
Truog

Jones
Delaware (Sodieum acetate)
pH

2. Physical analysis.

Mechanical analysis	12
Moisture equivalent	6

3. Physico-chemical determinations.

Dilatometer determinations	1
Heat of wetting	1
Colloidal content	1
pH value	2

It is evident from this summary of the work now being carried on that total chemical analysis makes up a large part of the laboratory work, "Availability" or solubility methods are being used to a very limited extent at present, although as will be shown later the interest in such methods is very great.

Of the various physical determinations, mechanical analysis, along with the moisture equivalent determination are the only ones of importance.

Of the physico-chemical determinations, use has not as yet become very general.

It is recognized that many of these methods are being used rather extensively in research projects, but as yet have not been taken up in the Soil Survey laboratory.

B. Additional determinations which would be of value, suggested in answer to the second question.

1. Complete chemical analysis of selected soils.

The value of complete chemical analysis in the study of soil development is of much importance, especially when soils are studies as such, rather than from the geological point of view. In fact chemical analysis must take the place of many of our generalizations based on the source and mode of origin of the soil. However the expense involved will limit the amount of this type of laboratory work.

The information secured from the analysis of extremely carefully selected samples undoubtedly will prove to be very valuable. The desirability of uniformity of methods, both in securing samples, also in making the analyses should be emphasized.

2. Mineralogical analysis of selected soils. The question as to the value of mineralogical analyses has been raised. As an aid in interpretation of complete chemical analyses it is of great value and is of use in the same field, that is in studying soil development. Up to a recent date

mineralogical analysis has been limited to determinations on the sand and silt separates, but it is very gratifying to learn that new methods have been devised whereby satisfactory determinations can be made on particles down to .001 mm in diameter. This opens up an entirely new field to the soil mineralogist.

3. "Availability" or solubility determinations. It is probably true that the desire for such methods is universal, but unfortunately thoroughly satisfactory methods are yet to be devised. The value of the present methods may be questionable, however, the results are interesting, and may in some cases be of as much value as a total determination.

4. Condition of combination of calcium in soils, whether as carbonate, hydrated silicate or silicate. Solubility methods combined with mineralogical analyses should throw some light on this problem.

5. Determination of colloidal clay, also colloidal organic matter. The need of further knowledge concerning the physical properties of the clay separate has been expressed. Methods for determining the colloidal content of soils have been largely indirect and in general unsatisfactory. A new method to be reported shortly has been devised by the Utah Station, work on soil colloids is also in progress at the Bureau of Soils and the Missouri Station. If a satisfactory method for estimation can be devised it will be of great value in the study of heavy soils.

6. Dilatometer measurements.

7. Heat of wetting.

8. Solubility measurements by the freezing point method.

These methods which have been devised by Professor McCool and his co-workers have proven to be of considerable value.

9. Moisture equivalent of soils.

This determination is being made by a number of Stations, and is looked upon with considerable favor. It gives a means of expressing or measuring the water requirement of soils. Considerable work has been done in studying the factors which effect the result of the determination on a given soil.

10. Permeability of soils. Additional studies are needed as to the physical nature of soils, especially as regards the heavy subsoil layer which has developed in many of our soils, and limits the rate of movement of water.

Standardization of methods. Undoubtedly every organization engaged in laboratory work has spent some time on methods, but in many cases results have not been published. The opportunity for cooperation between the various organizations in perfecting methods, and in the dissemination of information concerning methods of value is very great. Several of the Stations have indicated that Official Methods are used. A study of the methods used as

published in the soil survey reports reveals considerable variance, in some cases sufficient to effect the results obtained. An opportunity for constructive work is offered in the correlation of laboratory methods.

Committee on Correlative Laboratory Work.
G. W. Conrey
M. M. McCool
R. S. Smith

REPORT OF THE COMMITTEE ON THE FUTURE FIELD OF THE SOIL SURVEY WORKERS ASSOCIATION.

By M. F. Miller, Missouri.

The instructions of this association to the committee appointed to make recommendations regarding the future field of this organization were to consider three propositions; first, continuing the organization in its present form; second, enlarging the field of the association to include the whole subject matter of soils; and third, combining with the American Society of Agronomy or other organization. In the event that the committee recommended an expansion of the field of work it was also to suggest a suitable name for the organization.

As to the future scope and allocation of the work of this association, the committee has found it difficult to reach a satisfactory conclusion. It does not believe it wise, at this time, to recommend the formation of an association dealing with the whole subject matter of soil science, since this would doubtless be considered as infringing on the rights of the American Society of Agronomy and since such a plan should have the general sanction of the soils men of the country, rather than those concerned primarily with soil survey work.

There is a general feeling among the members of the committee that one strong organization representing the general subject of agronomy, with distinct sections for soils and crops, is preferable to two or more organizations dealing with different phases of the agronomic field. Should the soils men withdraw and form a new organization there would be danger that neither the old nor the new organization would survive. On the other hand, the soils work of the country is already represented by a rather strong periodical in "Soil Science" and it is possible that an organization of soils men might be able to use this as an official organ and by a narrowing of interests form an association with greater vitality than the general agronomic organization. This, however, seems rather doubtful, and the committee is not ready to recommend such a radical departure at this time.

With reference to making this association a part of the American Society of Agronomy there are some real difficulties. There is no doubt that a simple fusing of the two organizations would result in the obliteration of this one. Moreover, the setting apart of a certain session of the Agronomy Society program for the consideration of soil survey problems would not serve to bring together a representative number of soil survey workers.

The only plan that seems at all feasible in the matter of an organic union with the Society of Agronomy is to ask that association to establish a soils section, or possibly a field soils section to which one or two days programs should be devoted at each meeting. It seems doubtful if the Society of Agronomy would look with favor on a field soils section, while if a general soils section were established the tendency would probably be to consider subjects having to do with soil treatment and management rather than those dealing with field soils.

Another disadvantage to meeting with the Society of Agronomy is that these meetings are usually held in connection with those of the Land Grant Colleges, at points which are often very inconveniently reached by a large body of soil survey men. This would doubtless result in a poor attendance of active soil survey workers, and thus greatly lessen the value of the meetings.

Another plan which has been suggested is that of affiliating with the Society of Agronomy but as a distinct organization. In this case the association might meet with the Society of Agronomy on those years when the meeting place was desirably located, and possibly on other years it could hold separate meetings, in a more central location, yet in direct affiliation with that society.

The committee must admit frankly that it has not been able to reach a satisfactory conclusion regarding these matters. It believes that the subject will require the joint consideration of representatives of this organization, of other interested soils men and of representatives of the American Society of Agronomy, in order that a sane and satisfactory conclusion may be reached. Moreover, the committee feels that we have by no means exhausted the subjects of immediate importance in soil survey work and that we can advantageously hold at least one more meeting under the present plan.

The committee, therefore, RECOMMENDS that the present organization be continued without change of name, or of field, and without special affiliation with other organizations for at least another year, during which time the matter may be carefully considered by representatives of this association, representatives from the American Society of Agronomy and others who are interested.

Respectfully submitted,

C. F. Marbut
R. Harcourt
F. J. Alway
P. E. Brown
M. F. Miller, Chairman.

Committee.

REPORT OF THE COMMITTEE ON THE CLASSIFICATION OF ORGANIC SOILS.

By F. J. Alway, University of Minnesota.

The committee recommends as a report of progress:

A). That the committee be continued.
B). That the profile of organic soils be given careful study.
C). That the Chief of the Bureau of Soils of the Department of Agriculture be requested to assign one of the most experienced field men of the Bureau, and preferably one who is well acquainted with the organic soils of the Gulf states, to visit before the next meeting of the Association at least the Gulf states, California, Idaho, Minnesota, Wisconsin, Iowa, Illinois, Indiana, Ohio, Michigan, New York and Massachusetts, to study the profile of these soils and collect representative samples, working in cooperation with the respective Agricultural Experiment Stations wherever these are able to assist, and on the basis of these studies to recommend for the consideration of the committee a scheme of classification.
D). That in describing these soils at least the following properties be recognized:

1) Content of mineral matter.
2) Degree of decomposition, or comminution, of the plant residues in the virgin soils.
3) Thickness or depth of the organic layer.
4) Character of mineral substratum, where the peat is not too deep for this to be conveniently determined.
5) Color.
6) Adequacy of the lime supply and saline or "alkali" character.

The character of the native vegetation, while not being recognized in the classification, should be recorded by the field men wherever it has not been destroyed or seriously modified.

Notes on Suggestions in D.

1) Content of mineral matter.
   a) Conclusions of the field man as to the relative content of mineral matter should be confirmed or corrected by ash determinations of a sufficient number of representative samples.
   b) Three subdivisions are suggested, preferably retaining the terms peat and muck for the two highest in organic matter.
   c) Vegetable or loaf mold should be distinguished from peat and muck.
2) Degree of comminution or decomposition.
   a) Virgin soils should be considered in dealing with this property, but where adjacent soil has been under cultivation for some years the degree of comminution of the surface of this should be reported.

b) Three subdivisions are suggested--fine, granular and coarse (or fibrous).

3) Thickness or depth.
   a) Three divisions are suggested, namely:
      1) Deep--more than 3 feet or beyond the reach of the ordinary soil auger.
      2) Shallow--from 12 to 36 inches in thickness.
      3) Very shallow--less than 12 inches deep and hence liable to have the mineral substratum brought to the surface in the course of tillage operations.

4) Character of the mineral substratum.
   In general the recognition of this is feasible only with shallow peats and for these five subdivisions are suggested, namely those where the substratum consists of, a) Sand or gravel. b) Clayey or silty material. c) Marl. d) Stones and boulders. e) Rock (country rock).

5) Color.
   a) The color of the virgin soil should be dealt with, but, if any of the soil has been under cultivation for some years it is desirable to also report upon the color of this.
   b) Color standards should be established from the collection which the Bureau of Soils is requested to make.

6) Chemical composition.
   a) The adequacy of the lime supply for ordinary farm crops should be recognized in the classification insofar as such adequacy has been established by farm practice or can be decided upon from the chemical analysis of representative samples. The ordinary simple tests for acidity are recognized as not dependable in the case of these soils.
   b) Where the content of soluble salts is sufficient to be injurious to crops this should be recognized by such terms as "saline" and "alkali."

COMMITTEE ON CLASSIFICATION OF ORGANIC SOILS.

F. J. Alway
A. R. Whitson
M. M. McCool
S. D. Conner
R. S. Smith
C. F. Shaw
H. H. Bennett.

SOME SUGGESTIONS REGARDING SOIL SURVEY REPORTS AND THE SOIL SURVEY.

By Macy H. Lapham, Inspector, Western Division
Bureau of Soils.

Analysis of some of the earlier, later and present day soil survey reports presents some interesting comparisons indicative of the development in the science of soil surveying and in the art of presenting the data accumulated in the field, from which it is believed some pertinent suggestions may be gleaned.

The first of these, written during the experimental and early formative stages of the soil survey were without precedent or prescribed uniform method of treatment, or were suggested in scope, style or form by few previous publications of such character. Nevertheless they mark what will some day be recognized as one of the milestones in the development of American agricultural research, though in the light of present day standards of conciseness, definiteness and uniformity they leave much to be desired.

In the discussion of physiography and geology which in the earlier reports is accorded the place of a distinct chapter, there is a tendency to dwell too much upon problems of regional physiographic development and geologic history, and to give too meager discussion of such features in relation to soil formation, soil differentiation and soil utilization,-- a questionable practice from which we are not yet entirely divorced.

Discussion of Agriculture in the earlier reports is reserved for the last under head of a general chapter on Agricultural Methods. In the western surveys additional chapters on Water Supply for Irrigation, Underground and Seepage Waters, Alkali in Soils, and Alkali Land Reclamation are frequently included, in which some of us have plunged into discussion of highly technical problems in considerable detail. In some cases predictions were freely made as to future status with regard to alkali problems, based upon incomplete or unreliable data, and which have resulted later in harmful criticism. It might be said in passing that it now appears that the specialists in the physics and chemistry of alkali soils and alkali land reclamation, have by their own confession found so many things yet to be learned that there is a tendency in present day soil survey reports to discourage attempts to discuss the problem with finality, or to enter far into predictions for the future, and to confine treatment of this subject to a simple statement of facts as regards amount and distribution of alkali accumulation as indicated by field tests and visual evidences.

In the earlier of the reports there is no general chapter on Soils, or discussion under this head is incomplete and inadequate; and under description of soil types dominant soil characteristics of color, structure, development or occurrence of distinctive subsoils, substrata or horizons, etc.; now recognized of so much importance in soil classification, are

entirely or almost wholly overlooked. Any attempt to correlate soils encountered in the later surveys with those of these earlier areas on the basis of their description alone is futile.

The sequence of soil type descriptions was frequently arranged in a haphazzard manner, usually in the order of their extent or agricultural importance, and without regard to order in which previous mention of the soils may have been made or to relation of the soils to the series classification or to each other. This rendered it difficult for the layman to acquire a clear conception of, or to hold in mind the soil series relationships.

The soil type descriptions were, and still are in most instances, preceded by a table enumerating the various soil types in order of their extent. (See Anaheim Area, Cal, Field Operations, 1916). Should not this table rather be so arranged that the soils will be consequtively indicated in their natural relationship with regard to province or major groups, than to series and types, as for instance in the report upon the Reconnoissance Soil Survey of the San Francisco Bay region, (Field Operations, 1914). In this report this table is arranged first with regard to the mode of accumulation or derivation of the material, enumerating (1) the soils derived from residual materials, (2) the soils derived from coastal plain and old valley filling materials, (3) the soils derived from recent alluv ial materials; and (4) the soils derived from wind laid materials.

Under each of these major or province groups as the "soil province" is recognized in the western states, are indicated in uniform order the distinctive color differences as for instance, red soils, reddish brown soils, brown soils, yellow soils, and black soils. Each of these subheads is followed by the series names properly included, the Aiken series and the Sites series representing the red soils, the Holland series and the Olympic series representing the brown soils, etc., each of which is followed by enumeration of the individual types in order of textural progression from the coarser to the finer materials. (Exhibit table enumerating soils of the Anaheim Area rearranged according to tabular arrangement suggested). In other words this table can be made to serve a two-fold purpose if arranged in the same sequence in which the series and types are logically discussed in the report, explanatory not only of the relative extent of the various types, but of their mutual relationship and of the principles of their differentiation. Might we not consistently go a step further in this and introduce in the map legend the tabular arrangement suggested above with such modifications as might be prompted by local conditions?

With the later development of the principles of soil classification and differentiation, and improvement in field technique, has come a more complete and precise description of the soil type as formulated in the official approved outline for soil survey reports. Even with this as a guide, however, soil type descriptions are frequently too brief and woefully inadequate, and characteristics of color, texture, structure, depth or

thickness of the surface soil or underlying horizons or strata, or other important features are often slurred over or overlooked.

In the soil series descriptions not only should these be complete in every detail with respect to the typical material of an established series as recognized in previous surveys, but greater attention should be given to describing and explaining variations or inclusions which may occur in the area under discussion, which are recognized as departing from the typical but which are included for reasons which should be clearly stated. In some cases in which this is overlooked a description of the typical series material is given, followed later by description of individual types under this series recognized in the individual area as representing local variations or inclusions, and which conflict in color, profile or some other important characteristic with the series description previously given. Such instances lead to confusion in the mind of the layman who attempts to utilize the soil survey reports and gives opportunity for criticism of our service and our work.

It is further suggested that more frequent practice be made of stating in a few words the salient distinctions by which each series is differentiated from the soils of the related or associated series occurring in the area.

There is also in the mind of the writer, grave doubt as to whether the soil series descriptions should not better be removed from the general chapter on soils and given in connection with the soil type descriptions, the description of each series to be followed in order with discussion of its individual members or types. Such manner of treatment is logical and aids the mind in grasping and assimulating the principles of soil differentiation and series relationships. This appears to be desirable particularly in areas in which a large number of soil series and types are concerned as in some of the western reconnoissance surveys in which this practice has been followed. (See Reconnoissance Soil Survey of the San Francisco Bay Region, Cal. Field Operations 1914; Reconnoissance Soil Survey of the Central Southern Area, Cal. 1917). Objections have been offered in case of reports upon the Eastern and Middle States, however, that were this to be followed there would be little or nothing left for the general chapter on soils. We are now finding so many new and interesting things in connection with soil accumulation and soil development, and the relation of the various series to each other, that in the western areas at least where soils derived from a variety of sources, accumulated by various agencies, and exhibiting widely different characteristics, often occur within a single small valley or area, this objection now seems hardly tenable. Furthermore explanation or definition of the units of classification and of the nomenclature of the soil survey properly falls under this chapter.

There is in every soil survey report a question as to how much space, if any, should be devoted to definition and explanation of what is meant by the soil province or the soil region, the soil series, the soil type,

the soil phase or other technical terms and units of which use is made, or in calling to the attention of the reader inherent limitations which occur in the field classification of soils and their delineation upon the soil map. In the western reports the inspector has in most cases written and inserted definition or interpretation of such terms which are seldom explained by the author of the report. Such material is admittedly of little use to the soil technician or to one familiar with the principles of soil surveying and accustomed to the use of soil survey reports, in which case it occupies needless space and adds to the cost of publication. We must, however, bear in mind that a large proportion of the soil survey maps and reports are utilized by farmers, bankers, real estate operators, engineers and men of various professions who are not familiar with our system of soil classification or the terms in use. Brief treatment of what may be termed "basic definitions" explanatory of the terms and units of classification and mapping would, therefore, seem necessary that the soil survey reports might be clearly understood and fully utilized. Even in the official bulletins or other publications of the cooperating State Experiment Stations in which attempt is made to adopt the nomenclature of the soil survey there is frequent evident misunderstanding and misuse of soil terms, particularly those pertaining to the soil series and the soil type.

This problem is not peculiar to the soil survey. Much the same condition exists with regard to the Geologic Folios published by the U. S. Geological Survey. In these, explanation of the purpose, utilization and limitations of the topographic and geologic maps and of the terms and units of geological classification, is concisely given and printed in small type on the inside covers of the Folio. The trained geologist does not need to bother with these but may turn at once to the body of the report. To the layman they are essential in understanding and utilizing the text.

Might it not be possible to have prepared full but complete and carefully worded definitions and explanations of similar technical units and terms encountered in soil survey literature, to be uniformly printed in small type on the inside cover of the soil survey report or if this be impracticable to be inserted in the chapter on soils or as an appendix to which the casual reader may be referred? Such definitions or concise descriptive material might be drawn up by the Bureau of Soils or by a Committee to be appointed from within the body of this Association. It could be printed or mimeographed and inserted in its proper place in the manuscript by the Editorial Division, thus saving the time of the author or the inspector who would otherwise be responsible for its preparation. Should this procedure not be deemed feasible, then explanation of such units and terms necessary in fully understanding and utilizing the reports should by all means be provided for in our outline under the general chapter on soils.

Criticism is sometimes made of the present day reports following uniformly the prescribed outline from the standpoint that both writing and reading the manuscript is monotonous and that little opportunity is left for individuality of the writer. Would not a greater latitude allowed the author

result in a more readable paper? The answer is that the purpose of the soil survey report is to tell the story of the soil survey, simply, concisely and completely, and that the soil survey data which is accumulated in various localities by various field men should be presented in a systematic, uniform manner. By such method of treatment not only are results in individual cases better attained, but comparison of data from different localities is greatly simplified and its correlation facilitated.

Another suggestion which is ventured is that the soil maps, particularly those covering large areas, be not bound in the text but published separately, folded and inserted loose in an envelope or folder. For a precedent we have but to refer to various publications of the U. S. Geological Survey. (See Water Supply Paper 490-A, Routes to Desert Watering places in the Salton Sea Region, Cal.). In at least one of our soil survey reports a similar expedient by means of which both the report and folded maps are inserted loose in a neat folder has been tried and found commendable. (See Reconnoissance Soil Survey of the Western Puget Sound Basin, Wash. 1910). (See Fresno Area, Cal.: Reconnoissance survey, Central Southern Area, Cal,; Reconnoissance survey, Sacramento Valley, Cal.).

Another criticism which might be made of the soil survey reports is the lack of references to Departmental, State or other publications dealing with technical subjects with which the field man comes in contact, and which he frequently touches upon in his report. Most of our work is now conducted in cooperation with State institutions under which experts and specialists are frequently investigating the very problems encountered or touched upon in a general way in the soil survey report. In many instances reports have been published upon these problems, of which the author of the report is in ignorance, or to which he fails to give credit due.

The field man would be greatly assisted by supplying him with a list of available publications of the Department bearing upon soil and farm problems with which he might come in contact, and further might not this be supplemented by forwarding him reports, bulletins or other publications from the Departmental library if there be any, having specific bearing upon the area being surveyed? Is there not someone in the Washington office who could inaugurate an "extension service" to soil surveyors?

Upon some of us have become indelibly fixed the results of years of isolation in the field, during much of which there was little or no systematic field inspection, no regular visits of the inspector with their opportunity for helpful criticism and encouragement, and during which for intervals of one or two years or more the field party seldom if ever came in contact with any person from their own or other technical departments of either the Federal Government or State. The irregular and infrequent visit of some one from the Washington office at such times assumed almost the importance of an event of a lifetime. Present systematic organization of the soil survey with regular field inspection and active cooperation with the States has done much to alleviate this condition of isolation, but to the writer, herein still lies one of the greatest opportunities of the Inspector to be of real service.

He has within his grasp the opportunity of being not only a critic and a scientist, but a humanizing agent, a source of inspiration and of kindly helpfulness, a purveyor of the news and family gossip concerning the activities and plans of the soil survey so keenly relished by him who is constantly in the field, by means of all of which he may assist in maintaining that intangible but no less highly essential asset of the soil survey which has been so evident under past trying circumstances, the morale and spirit of the field force.

CLASSIFICATION AND AREA OF SOILS.

ANAHEIM AREA, CALIF.

Soil Series and Types.	Acres	Per cent
Residual soils:		
Brown soils:		
Altamont series (Derived from sedimentary rocks)		
Altamont fine sandy loam.	5,632	1.8
Altamont loam	14,208	4.5
Altamont clay loam	12,224	3.9
Altamont clay	704	.2
Altamont clay adobe	3,008	1.0
Dark gray to black soils:		
Diablo series (Derived from sedimentary rocks)		
Diablo clay adobe	832	.3
Coastal Plain and Old Valley Filling Soils:		
Brown soils:		
Ramona series (Derived mainly from granitic rocks)		
Ramona sand	960	.3
Ramona sandy loam	5,440	1.7
Ramona fine sandy loam	15,360	4.8
Ramona gravelly loam	3,072	1.0
Ramona loam	31,120	6.7
Ramona clay loam	9,152	2.9
Antioch series (Derived mainly from sedimentary rocks)		
Antioch clay adobe	2,368	.7
Dark gray to black soils:		
Montezuma series (Derived from mixed rocks)		
Montezuma clay loam adobe	2,304	.7
Montezuma clay adobe	1,728	.5
Recent alluvial soils:		
Brown soils		
Hanford series (Derived mainly from granitic rocks)		
Hanford sand	12,554	4.0
Hanford sandy loam	29,056	9.2
Hanford fine sandy loam	47,360	14.9
Hanford loam	10,816	3.4
Yolo series (Derived mainly from sedimentary rocks)		
Yolo fine sandy loam	5,888	1.9
Yolo loam	27,456	8.6
Yolo clay loam	14,720	4.6
Yolo clay adobe	2,560	.8

Soil Types and Series	Acres	Per cent
Recent alluvial soils, cont'd.:		
Dark gray to black soils:		
Dublin series (Derived mainly from sedimentary rocks).		
Dublin clay adobe	1,664	.5
Chino series (Derived mainly from granitic rocks)		
Chino silt loam	4,480	1.4
Chino silty clay loam	5,056	1.6
Chino clay loam	6,080	1.9
Chino silty clay	13,248	4.1
Miscellaneous materials:		
Muck and Peat	1,024	.3
Tidal marsh	5,312	1.7
Coastal beach and dunesand	1,344	.4
Riverwash	2,432	.8
Rough broken and stony land	28,288	8.9

SOIL SURVEY REPORTS.

By H. H. Krusekopf, University of Missouri.

The effective presentation to the general reader of the results of investigation is a matter which workers in the field of agriculture have had to consider and to deal with for many years. Soil reports are the means by which are recorded the findings of soil survey investigations. During the past ten years great progress has been made in refining soil mapping and in making it a really scientific work. Soil reports have not changed much in content and form, and have not kept pace with the advance in soil mapping. I have no desire to minimize the great value of the soil report in its present form, yet it is evident that our increasing fund of soil knowledge, as revealed by the soil survey does not find adequate expression in the soil report. The need of a change in the reports has been felt for a long time. The subject has been discussed at the two previous meetings of this Association, and some valuable suggestions have been made. However, since no definite action has as yet been taken to modify soil reports, a further discussion of the subject seems still in order.

Because of the wide range of uses of these reports and the many classes of people to which they must appeal, there are many opinions as to what a soil report should and should not contain. The question at once arises--should the soil survey report be a technical or popular paper? Since soil surveying is a scientific study of soils, it seems logical that the soil report should be a technical paper. To prepare it in this form is the ideal report. However, practical considerations at once made such a plan impractical. The readers to whom such reports would appeal are entirely too limited to justify their publication. Moreover, the difficulty of getting appropriations for such work must be considered. Again not all soil workers have the soil knowledge to prepare a really technical paper. Soil reports must, therefore, be popular papers, written in such a way as to be easily read and understood by the layman or man of ordinary education.

In the preparation of soil reports, there are three general classes of readers that are to be considered:

1. The farmer
2. Student and investigator
3. Banker, realtor, investor and general public

It seems right that the report should be written primarily for the farmers, but not wholly so. The survey stands for a broader relation than the local agriculture. It is a contribution to the knowledge of soils. The report should be instructive as well as informing, it should be scientific in its purport and interpretation, and not alone a record of observations and facts whose relationship are not traced and whose real significance is not indicated. All information obtained on the soils of the surveyed area needs to be recorded for the benefit of advancement in soil science, even when such information has no apparent practical value.

Hence the soil surveyor cannot afford to restrict his audience to farmers, or leave out of his thinking the man in the laboratory and in the office.

The criticism has been made that soil reports employ too many terms that are not generally known or understood by the layman. I cannot agree to this. To popularize the soil report should not be construed as writing down to the public. The fault is more largely with the reader because of his limited soil vocabulary. Every field man has realized the very limited number of soil terms used by farmers and the general public. I dare say that the majority of people do not have more than a half dozen soil terms at their command, and these are confined to such general terms as sand, clay, loam. Although silt loams are the dominant soils of the United States, yet the word silt is rarely used by the layman (many people are credited with having "sand" but few there are that have silt--in their vocabulary). There seems only one solution of this problem, and that is to educate the readers to the use of the more common soil terms.

In this connection it can be said that our whole soil language is as yet too limited even among soil workers. Our soil terminology does not always enable an exact definition or description of soils as brought about by increased soil knowledge. The inadequacy of soil language particularly as it pertains to soil structure is apparent. Not only are the terms few, but those now in use are given a variety of meanings. I doubt if there are any two soil surveyors who have the same concept of the words tight, compact, impervious, mottled, stratified, etc., when applied to soil. Moreover, of late there has been adopted the use of foreign terms, some of which seems desirable while others ought to be discarded. It seems within the scope of this organization to have a committee to take up the consideration of enlarging and defining more exactly our soil terminology. The creation of such a committee is recommended.

In considering changes of the soil report proper, I would suggest first that the report be made what its name indicates--a soil report. Our present reports are as much agricultural and geographical reports as soil reports and because of this fact the study of soils as a science has not received its just recognition or deserved importance. We have been using too much material that belongs more to geology, geography, and history and because of this, attention has been diverted to a large extent from the main subject, which should be a complete soils discussion.

In proposing an outline for soil survey reports, I suggest the following order:

A. A short introductory chapter--this to include a brief description of the county or survey area as to its location and general topographic features. In giving the location all statements as to latitude and longitude and the names of bounding counties should be omitted. The general surface features should be described briefly. However, a description of the courses of streams and of all other minor cultural features that are shown on the soil map should not be included under topography. The native vegetation, industries and natural resources deserve mention as far as they have a relation to the agricultural conditions in the area. All historical data,

discussion of the roads, mail routes, etc., should be omitted. In brief, the introductory chapter should merely give a "birdseye" of the important natural features of the survey area.

B. The second chapter would be a general chapter on soils of the area. It is my opinion that this chapter should be the most important part of the whole report. It should be a really complete and comprehensive discussion of the soils as to their character, relationship and economic limitations. Some of the factors that might be considered are as follows:

1. The relation of the soils of the surveyed area to the larger region or adjoining areas. (Ex. Knox County part of N. E. Mo. level prairie region).

2. What are the general characteristics of the soils--as to color, texture, character of subsoil, content of organic matter, sourness, etc. This will be essentially a description of the generalized profile or profiles of the soils of the area. The cause of soil conditions accrelated to progressive soil development, origin, etc.

3. On the basis of soil character, point out which are the major and which the minor factors in soil classification. Each report should include a brief discussion on soil classification and nomenclature.

4. What is the relation of soil character to crop production? To crop adaptation or plant rotation? (Ex. Alfalfa on open subsoils.)

5. What is the relative importance of structure in its effect on crop yields?

6. Why is a given soil type or group of soils suitable to the production of specific crops?

7. What is the relation of soil character to moisture holding capacity?

8. How are soil conditions influenced by natural and artificial drainage?

9. To what extent can natural soil conditions be improved or modified in a practical way?

There are other topics that might be discussed that will vary according to local conditions of each survey area. It is essential that this chapter embody all the knowledge obtained on the soilsof the area. It should not only describe the general soil conditions, but also explain as far as possible the cause for such conditions. The significance of the various soil conditions in their relation to the economic utilization of the soils should also receive due consideration.

It might be charged that such a discussion of the soils will be too technical for the general reader. I do not agree to this. When the survey of an area has been completed, the surveyor has a thorough knowledge of the

soils, and ought not have trouble to state in simple terms the information he has acquired. It is much less a matter of skill in popular composition than of clear thinking and plain expression.

C. Following the chapter on soils are the soil type descriptions. This part of the present soil reports seems satisfactory, although the discussion on minor soil variations frequently is too long. All soil management should be included under type descriptions. The value of the report would be increased considerably to have it include a discussion of the practical problems that are met in the management of each soil type with instructions regarding profitable soil treatment. The majority of farmers using soil reports will be interested primarily in the soil types on their own farm, and in order that all recommendations might be as definite and specific as possible, it seems best to discuss the soil management for each type (or group of similar types) even at the expense of some repetition.

It is evident that there are chances for errors and misstatements on soil management to creep in. An inexperienced or overenthusiastic report-writer might include matter that cannot be verified. To avoid errors of this sort, it is recommended that all soil reports should be submitted to the state authorities when the first draft of the report is completed by the field man--in all states where a cooperative arrangement exists between the Bureau and the State.

D. The chapter on agriculture coming next, should be a brief, general description of the agricultural conditions in the county with an interpretation of these conditions to the soil conditions. If the relationship of the agriculture to the soils is not defined, then the chapter on agriculture loses its real significance and has no place in a soil report. A deserved criticism of this part of soil reports is that it is given too much of mere description, much of it on unimportant or well known matter. Thus a discussion on the preparation of the seed bed, date of seeding, time of marketing, breeds of livestock, etc., should be omitted. More attention should be given to discussing the possibilities of expansion as well as the limitations of agricultural practices. Similarly, the possibilities for the introduction of new industries, and the growing of special and general crops should receive due consideration. In general, the Chapter on Agriculture should be interpretive rather than descriptive.

E. No special changes are suggested for the Chapter on Climate as it is now prepared. It seems desirable that in regions of extreme climatic conditions, the data on climate be even more complete. In every case, however, the discussion on climate should not be per se, but should define the relation of the climate to the soil and agricultural conditions. Following the body of the report may be added tables and charts on soil composition, data on crop yields, farm management tables, all of which should be an aid in interpreting the soils and agriculture of the survey area.

The summary now included in soil reports is of little value and ought to be omitted. Soil reports are unlike the average Experiment Station Bulletin which usually presents one or more conclusions. A summary of these is feasible and desirable.

One other feature of soil reports that deserves greater consideration, is to include more illustrative material. A few well chosen pictures will take the place of much description on topography and agriculture. Illustrations of representative soil sections or profiles would be an aid in defining soil structure and character. Even charts and diagrams to illustrate soil conditions seems desirable.

The adoption and use of such an outline for soil survey reports would add greatly to their usefulness and clearness and make them more nearly comply with the requirements of a real soil report. In a general way, the three principal parts of the report--the chapter on soils, soil types, and agriculture would meet the requirements of the three groups of readers. The investigator and student of soils would find in the general chapter on soils a complete record of soil information of the area. The chapter on soil types is mainly utilitarian or practical in its aspect, and would meet the requirements of the farmer. The general public is interested primarily in information on the relation of the soils to the agriculture of the area, and this would be supplied in the chapter on agriculture.

Discussion of Address - "Soil Survey Reports" - H. H. Krusekopf

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"I agree with Mr. Krusekopf in the fore part of his suggestions, especially the elimination of the conclusions, and make a little more of the introductory chapter. In Banks or real estate offices you very rarely find a soil map. We are putting out some mighty good stuff if they would use it. Possibly one reason they don't use it, we don't put it in a form that they can readily get hold of it. If we could just give them a bird's eye view of the county as a whole so that they could get it sized up, we would get a whole lot of those people interested. I wish to note one very marked exception to this. The Missouri Savings Bank of Kansas City puts out as many loans or more than any institution in western Missouri. They use our reports constantly and find them of great help, but it seems to me that something should be done to put this line of good stuff where that class of people will use it more extensively."

Dr. Marbut -

"I am very much pleased to hear the paper as a whole. I think if it were adopted, it would be a good move in the right direction, especially the suggestion that the soils chapter should be much longer than it is now and should contain the greater part of the general description, and it seems to me in this connection, the soils chapter could very well start out by giving the high lights. In every region there is a predominant soil and that soil has a particular profile. In starting out the soils chapter, that dominant soil should be carefully described, its importance brought out. That dominant soil is usually the mature soil of the region and every other soil in the county is usually related to that one. The soils are either young, not developed, or the soils are old, and all the soils in the county could be described with reference to this mature soil. If that form of report should

be adopted, it would add a great deal to the value of our soil reports.

"The chapter on agriculture, relationships between soils and agriculture, is a good suggestion. I see no reason why the agriculture should not be described in that report. In order to interpret the agriculture it must be presented. The soils have been described, then the agriculture should be described and the two correlated. The main point is to put that in a place where it can be made into an interpretative chapter."

Dr. Conrey -

"If the discussion of climate is simply a statement of climatic data, it seems to me that here is an opportunity for interpretation. Two or three tables on rainfall and growing season are of very little value."

Dr. Condra -

"In regard to the climate, we have been thinking of putting a map in showing the isotherm lines, the number of growing days in the year, the first frost in autumn, the last frost in spring, in short, a bird's eye view of the weather of the county showing its relation to agriculture."

P. E. Brown -

"It seems to me that some of the suggestions are very good; however, I wonder whether the report put up in this shape will be more popular or more technical. These reports are to go before a certain group of people whose attention wants to be attracted, and if we are going to start putting a description of the topographic or physical characteristics of the area first, it is a question whether the people are going to read any farther. If the chapter on agriculture is put in the last of the report, you have taken away any possibility of getting a popular presentation of the report. You will notice that I am not saying that the Bureau report should be in a popular shape, but do you want the Bureau report put out in a more popular shape than at present or not? You must attract your audience by putting the chapter on agriculture first to make it more popular.

"How logical would it be to put a chapter on agriculture in a soil report?"

Dr. Brown -

"My relations with the agricultural press have impressed upon me very emphatically that you have got to attract the attention of the agricultural public, otherwise the public will not read the article."

H. L. Walster -

"After we have got all these reports written up, I would like to ask if our Committee on Legislation has considered any better schemes for getting

at and making available the federal reports? It is a matter of historic record that valuable reports have been lost, and what has become of them is a mystery."

Prof. Wiancko -

"I don't know exactly what ought to be done. I have noticed this time and time again, that our county agents, for instance, who ought to make use of these reports, don't do it to a large extent. Whether it is because he doesn't know how, or is it in a form so that he can't use it?"

"Have you ever polled the county agents on why they don't use it?"

Prof. Wiancko -

"Yes , a lot of them have the idea that there is nothing much in it."

H. H. Lewis -

"This summer in the county where I have been working in New York, Mr. Baker, the county agent, has been very much interested in the soil survey of the county. He wanted to go out with us and that evening he said, "'I am very glad to have gone, I have learned something. '" Another county agent said he knew the soils in general but he was surprised to know that there were so many variations of the soils in that county. The various county agents are very anxious to go on with it, and find out what we are doing so that they can give it to the farmers."

Dr. Marbut -

"I move that we endorse the outline presented by Mr. Krusekopf."

Prof. Alway -

"There are a good many men here and there is a good opportunity for some model reports to be written, and if each one would take one of the Bureau reports and make their suggestions for putting that into model form, I think it would be a good plan."

M. H. Lapham -

"I have prepared a little paper myself dealing with this subject, but owing to the fact that I did not know that I would be able to attend the meeting until recently, I failed to get a place on the program. If there is time I would like to read it, if not, there are a few additional suggestions that I would like to make."

THE RELATION BETWEEN SOIL TYPE AND CHEMICAL COMPOSITION

By E. E. DeTurk, University of Illinois.

INTRODUCTION.

The distinguishing of soil types for purposes of mapping as well as for other purposes is based very largely upon those characteristics, mainly physical, which may be determined with a considerable degree of accuracy by examination in the field. There is no question as to the reliability of separations made in this way. While in some cases one type passes gradually into another, so that no sharp boundary line can be determined, in the majority of cases the type boundaries are fairly distinct. In a consideration of the productivity of soils, however, agronomic investigators place a varying but distinct emphasis upon the importance of chemical composition. The importance of the chemical composition of soils as a factor in fertility may be illustrated by the well known fact that many unproductive areas, as for example the "barrens" of Maryland, contain but a trace of those chemical elements known to be essential in the normal growth of plants, even though the soil and climatic environment in other respects are favorable to plant growth. In contrast to this, the corn belt of the Mississippi Valley may be cited. It is recognized, to be sure, that the total amount of plant nutrient elements in a soil is only one of several factors affecting its productiveness, and consequently, that chemical composition, alone, may not be taken as a reliable guide in the practice of fertilization.

SCOPE OF STUDY

With this viewpoint in mind, two questions come rather prominently to one's attention. These are:

(1) To what extent do the soils within a given type vary in chemical composition, and is the variation entirely irregular, or does it progress in certain directions, due to climatic or other factors?

(2) Is the variation within a given type less than or greater than the variation from one type to another; in other words, are there boundary lines between soil types with respect to chemical composition as there are with respect to physical properties.

Within the limited scope of this paper, it has become necessary to confine the discussion to a small number of soil types and of chemical elements, in order to give adequate attention to any one of them. Three soil types have been selected, which are extensive in Illinois, which are widely distributed over the state, and which very frequently lie adjacent to each other in the field. Thus, there is provided in the three types chosen, a possibility of gradation from one into the other. These types are known in the Illinois Soil Survey as yellow-gray silt loam, an undulating, upland timber soil, distributed throughout the state; brown silt loam, the typical undulating prairie soil of the corn belt, occupying much of the area north of the Shelbyville moraine; and black clay loam, which occupies the more nearly level, and more poorly drained areas in the corn-belt

prairie. These soils probably correspond roughly with the Miami silt loam, Tama silt loam and Tama clay loam in the classification by the United States Bureau of Soils.

It is proposed to attempt to answer the two questions in part, with respect to organic carbon, total nitrogen and total phosphorus.

In the Illinois Soil Survey, soil samples of each type in a given county are analysed with respect to dry matter, nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, total carbon, carbonate carbon and lime requirement where the soils are acid. The organic carbon is obtained as the difference between total carbon and carbonate carbon. The soils from fifty-two counties have been analysed, the total number of samples of all types approximating 2000 for each of the three strata sampled, namely, 0" - 6 2/3", 6 2/3" - 20", and 20" - 40". In order to increase the number of analyses included in the individual averages, the counties were grouped as shown in Plate I, the boundary lines of the main soil areas being maintained, so that a given county may fall partly in two different groups. The shaded counties have been analysed. Thus each value given is the mean of varying numbers of analyses, ranging from 5 to 58.

VARIATION WITHIN THE TYPE

When individual samples are considered, the variation within a given type, even within a given county is very wide. This is illustrated by the following examples of minimum and maximum values, in the Upper Illinoisan Glaciation:

	Organic Carbon			Total Nitrogen			Total Phosphorus		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum
Surface, Y.G.S.L.	11,020	26,500	43,880	1320	2320	3600	600	820	1100
" Brown silt L.	35,560	58,660	83,600	3200	4600	6380	860	1130	1500
" Black clay L.	46,860	67,210	93,180	3840	6060	7800	1000	1650	2460
Subsurf. Y.G.S.L.	5,540	10,930	21,380	700	1131	1780	520	720	1020
" Brown silt L.	15,500	34,730	57,980	1330	3054	4400	660	890	1480
" Black clay L.	29,880	36,330	71,180	2440	3344	3980	740	1312	1640

In other soil areas the results are equally striking. It is obvious that but little importance may be attributed to individual analyses. That this is true is indicated by the probable errors of individual analyses, which were found to be large, ranging from 5.8 per cent to 19.5 per cent of the mean, in a number of cases which were computed. The probable errors of the means, however, ranging from 1.6 per cent to 5.7 per cent of the respective means, indicate that the averages here used fairly represent the type.

In order to determine whether the variations within a type are progressive in any direction, the means were charted by means of rectangles arranging them roughly in order from the south to the north of the state, but preserving the groupings by main soil areas (glaciations). Since the range of mean annual temperatures and the total rainfall varies rather greatly between the two ends of the state, it was thought that possibly climatic conditions may have affected the soil composition. Some correlation in the surface soils is exhibited by the analyses as shown in Tables 1, 3 and 5, particularly with respect to nitrogen and organic carbon, both of which are indexes of organic matter. It will be noted that these elements decrease as we go southward, a phenomenon which may be accounted for by the temperature and moisture conditions being more favorable to rapid decomposition of organic matter. In the subsurface soils no suck gradation occurs. The composition within a given type holds quite uniformly throughout the state.

Some differences are observed in the nitrogen and organic carbon content of the surface soils only, in passing from one soil area (Glaciation) to another. They, however, follow the trend noted above of increasing from south to north, with the exception that a decrease occurs in the soils of the Late Wisconsin and Iowan.

The variation in phosphorus content of both the surface and subsurface soils is entirely irregular, with the one excdption of brown silt loam surface. The apparent tendency to increase from south to north in this instance may be accidental.

The extent of variation within any of the types is wide. The increase of the maximum value over the minimum ranges from 25 per cent to 121 per cent, as illustrated in the following table.

Range of Mean Values for Organic Carbon, Nitrogen and Phosphorus

Soil	Organic Carbon			Total Nitrogen			Total Phosphorus		
	Min.	Max.	% incr. of Max. over Min.	Min.	Max.	% incr. of Max. over Min.	Min.	Max.	% incr. of Max over Min.
Surface, Y.G.S.L.	17830	30920	74	1720	2820	64	680	1020	50
" B.S.L.	47790	74420	55	3720	6320	70	990	1370	38
" Bl.Cl.L.	49720	96980	95	3900	8620	121	1200	1840	53
Subsurf. Y.G.S.L.	6910	12430	80	900	1200	33	630	990	57
" B.S.L.	28750	42030	46	2710	3440	27	810	1010	25
" Bl.Cl.L.	27870	49690	78	2550	3730	46	900	1420	58

The greatest variation occurs in the organic carbon content and the least in phosphorus. Surface soils exhibit more variation than subsurface soils by nearly 20 per cent. Of the three types studied, black clay loam varies most markedly and brown silt loam the least.

VARIATION BETWEEN TYPES

The extreme range of values as indicated by individual analyses would completely obliterate all "chemical" boundary lines between soil types. For the reasons stated above, the use of those values is not justified. A study of the average values as shown in Tables 1 to 6 shows a fairly sharp line of demarcation between yellow-gray silt loam on the one hand, and brown silt loam and black clay loam on the other, with respect to organic matter in the surface stratum as indicated by both nitrogen and organic carbon, but the line is rendered indistinct by a considerable degree of overlapping of values.

The phosphorus content of the surface soils increases gradually, but distinctly from yellow-gray silt loam through brown silt loam to black clay loam. The variation in phosphorus content of these soil types may be due in part to organic phosphorus accumulations in the surface stratum, since the difference in phosphorus content between yellow-gray silt loam and brown silt loam largely disappears in the subsurface. The black clay loam carries its phosphorus content well down into the subsurface, so that that type is rather sharply differentiated from the other two in the subsurface.

A study of the means, however, while it shows in general the differences between types does not give a reliable indication of the existence or non-existence of boundary lines between types with respect to chemical composition. A study of the frequency distributions seems to offer the best approach to this question and the relations are shown in (Tables VII to IX).

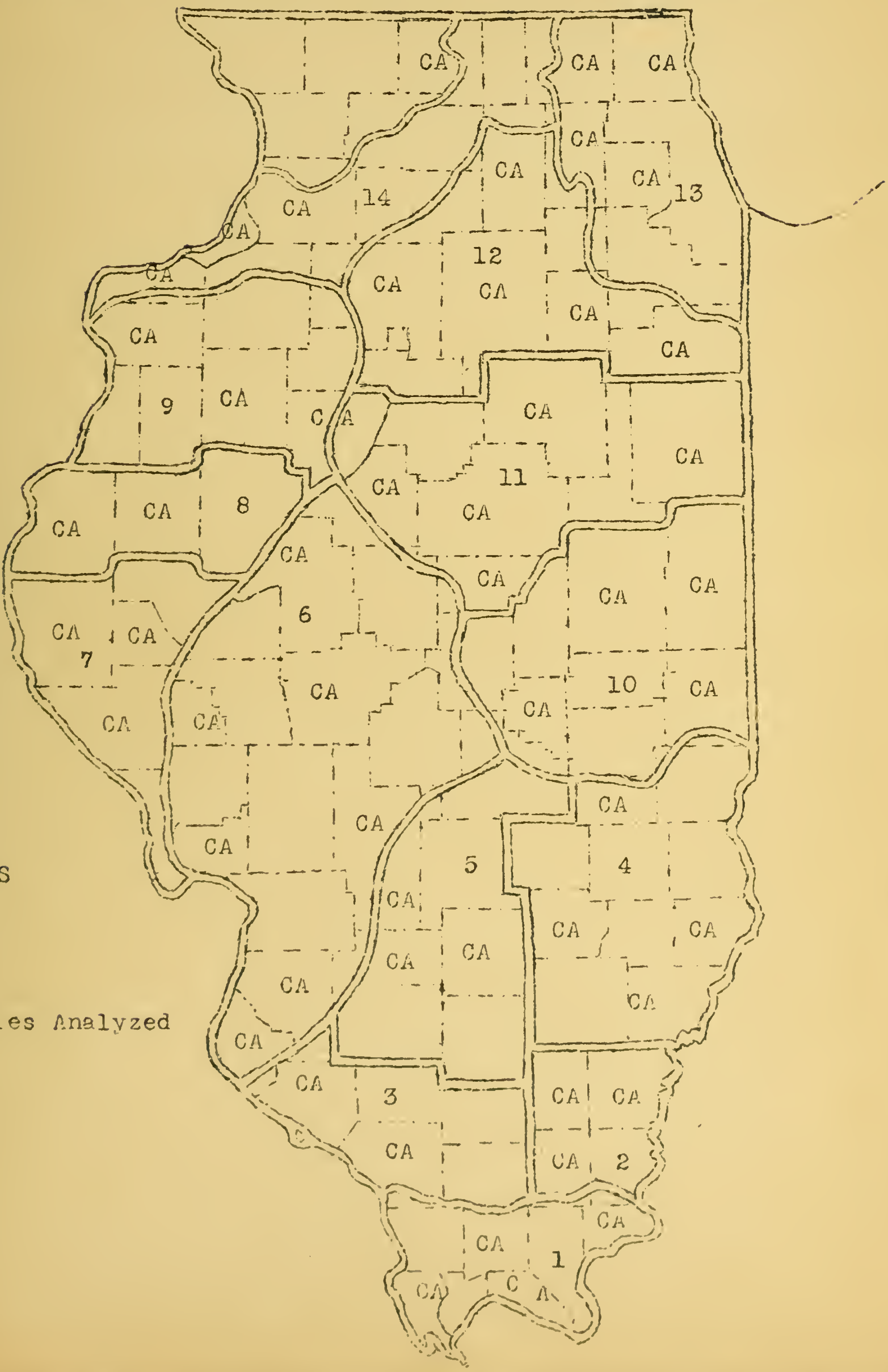
It will be noted that the line between yellow-gray silt loam and brown silt loam is particularly sharp with respect to organic carbon and nitrogen, in both strata, but that it is especially sharp in the subsurface. This can be explained in part by the fact that the natural surface stratum of brown silt loam extends well down into the subsurface as sampled, so that the subsurface samples approach the surface in organic matter content. On the other hand, the natural boundary between surface and subsurface of the yellow-gray silt loam coincides fairly closely with the arbitrary division line used in sampling.

It is obvious that there is no semblance of a division line between the brown silt loam and black clay loam soils in nitrogen and organic carbon, notwithstanding the fact that the latter soils contain, as a general average, notably larger amounts of these two elements.

In phosphorus content there is an evident differentiation between the three types examined, in the surface stratum, as shown by the separation of the modes, but the line is obscured by the overlapping of a large number of results. The differentiation disappears in the subsurface except in the black clay loam which stands out as distinctly above the other two in its content of phosphorus.

Plate I

Grouping of Counties for Study of Soil Analysis Data



ILLINOIS

CA--Counties Analyzed

Table I.

Yellow-gray silt loam

Summary

Surface 0" - 6 2/3"

Soil Area No. on map	Name	Number of counties	Number of analyses	Total organic carbon lbs. per 2 million		Total nitrogen lbs. per 2 million		Total phosphorus lbs. per 2 million		Number
1	Unglaciated	3	12	17,830	±522 **	1,720	±60 **	930	±23**	1
2	Lower Ill.	3	16	22,070	±703	2,020	±55	760	±22	2
3	" "	4	23	18,800	±415	1,760	±30	760	±19	3
4	" "	5	16	22,610	±1127	2,090	±10	800	±29	4
5	" "	4	12	22,920	± 844	2,220	±94	680	±41	5
Mean of Lower Ill.			67	21,230		1,920		760		
6	Middle Ill.	4	15	22,550	± 579	2,060	±73	900	±35	6
7	Upper Ill.	3	17	24,930	± 102	2,140*	±78	760	±18	7
8	" "	2	12	27,590	± 1907	2,450	±15	820	±27	8
9	" "	4	15	27,100	± 801	2,430	±60	880	±16	9
Mean of Upper Ill.			44	26,400		2,330		820		
10	Early Wis.	4	16	25,830	± 104	2,310	±96	820	±31	10
11	" "	4	11	30,920	±1459	2,820	±17	970	±39	11
12	" "	4	9	30,860	±1648	2,600	±12	1020	±33	12
Mean of Early Wis.			36	26,640		2,540		920		
13	Late Wis.	3	8	25,450	±1587	2,350	±15	810	±29	13
14	Iowan	4	5	21,400	± 669	2,010	±77	880	±30	14
Mean for type			187	23,940		2,180		830		

*N= 16

**Probable error in Tables 1 to VI were determined by the use of Peter's formula.

P.E. of mean equals $0.8453 \frac{\text{Sum}}{n} \frac{(\pm d)}{n-1}$ in which Sum (+d) represent the sum of the deviations of all individual analyses from their mean, disregarding the sign.

Table II.

Yellow-gray silt loam — Summary — Subsurface 6 2/3" - 20"

Soil Area No. on map	Name	Number of counties	Number of analyses	Total organic carbon lbs. per 2 million		Total nitrogen lbs. per 2 million		Total phosphorus lbs. per 2 million		Number
1	Unglaciated	3	11	5,910	± 270	900	±39	990	±37	1
2	Lower Ill.	3	16	9,870	± 491	1120	±39	700	±13	2
3	" "	4	23	7,990	± 191	910	±26	790	±22	3
4	" "	5	16	8,540	± 589	960	±64	670	±24	4
5	" "	4	12	10,070	± 579	1110	±66	710	±23	5
Mean of Lower Ill.			67	8,940		1010		730		
6	Middle Ill.	4	15	8,960	± 380	910	±40	840	±21	6
7	Upper Ill.	3	17	12,430	± 597	1170	±44	710	±17	7
8	" "	2	12	10,220	± 930	1100	±50	720	±26	8
9	" "	4	15	9,800	± 545	1120	±34	740	±18	9
Mean of Upper Ill.			44	10,930		1130		723		
10	Early Wis.	4	15	9,280	±2099	1100	±25	630	±19	10
11	" "	4	11	10,140	±2715	1200	±54	760	±20	11
12	" "	4	9	10,170	± 563	1080	±58	900	±32	12
Mean of Early Wis.			35	9,780		1130		740		
13	Late Wis.	3	8	10,420	± 437	1190	±84	740	±29	13
14	Iowan	4	5	8,300	± 717	1040	±68	910	±31	14
Mean for type			185	9,500		1050		740		

Table III.

Brown silt loam — Summary — Surface 0" - 6 2/3"

Soil Area No. on map	Name	Number of counties	Number of analyses	Total organic carbon lbs. per 2 million		Total nitrogen lbs. per 2 million		Total phosphorus lbs. per 2 million		Number
6	Middle Ill.	6	27	50,030	±1062	3,960	±72	1,000	±21	6
7	Upper Ill.	3	7	47,790	±1222	3,720	±135	990	±29	7
8	" "	2	17	49,740	±9028	4,130	± 72	1,060	±24	8
9	" "	4	36	64,910	±9516	4,990	± 62	1,190	±13	9
Mean of Upper Ill.			60	58,620		4,600		1,130		
10	Early Wis.	4	58	56,360	± 708	4,700*	± 52	1,040	±11	10
11	" "	5	58	59,790	± 948	4,940	± 80	1,090	±13	11
12	" "	6	57	69,040	±1472	5,730	±134	1,370	±25	12
Mean of Early Wis.			173	61,690		5,120		1,170		
13	Late Wis.	5	25	74,420	±2656	6,320	±187	1,370	±23	13
14	Iowan	4	9	62,130	±2566	5,210	±254	1,220	±33	14
Mean for type			294	61,090		5,010		1,110		

* N = 57

Table IV.

Brown silt loam | Summary | Subsurface 6 2/3" - 20"

Soil Area No. on map	Name	Number of counties	Number of analyses	Total organic carbon lbs. per 2 million		Total nitrogen lbs. per 2 million		Total phosphorus lbs. per 2 million		Number
6	Middle Ill.	6	27	36,540	±847	2,890	±893	860	±19	6
7	Upper Ill.	3	7	35,410	±973	2,710	±139	860	±38	7
8	" "	2	17	33,360	±894	2,790	± 63	910	±31	8
9	" "	4	36	42,020	±917	3,440	± 46	970	±13	9
Mean of Upper Ill.			60	38,630		3,170		940		
10	Early Wis.	4	58	35,320	±502	3,100	± 43	810	±11	10
11	" "	5	56	35,740	±597	3,100	±423	850	±13	11
12	" "	5	56	33,120	±740	2,960	± 57	1010	±17	12
Mean of Early Wis.			170	34,730		3,050		890		
13	Late Wis.	5	25	35,400	±126	3,190	±126	960	±20	13
14	Iowan	4	9	28,750	±176	2,720	±104	920	±13	14
Mean for type			291	35,615		3,061		904		

Table V.

Black clay loam Summary Surface 0" - 6 2/3"

Soil Area										
No. of Map	Name	Number of counties	Number of analyses	Total organic carbon lbs. per 2 million		Total nitrogen lbs. per 2 million		Total phosphorus lbs. per 2 million		Number
6	Middle Ill.	4	12	61,320	±2709	4,940	±2352	1,320	± 47	6
7	Upper Ill.	2	2	49,720	± 246	3,900	± 76	1,200	±169	7
8	" "	2	4	70,530	±5771	5,960	± 156	1,630	±439	8
9	" "	4	5	71,510	±1109	7,000	± 348	1,840	± 11	9
Mean of Upper Ill.			11	67,210		6,060		1,650		
10	Early Wis.	4	20	75,820	±2386	7,030	± 162	1,800	± 26	10
11	" "	7	32	75,740	±1555	6,990	± 170	1,690	± 49	11
12	" "	4	8	79,840	±4144	7,090	± 392	1,670	± 92	12
Mean of Early Wis.			60	76,460		7,020		1,720		
13	Late Wis.	2	3	96,980		8,620	± 837	1,830	±210	13
14	Iowan	None	--	--	--	--	--	--	--	14
Mean for type			86	73,880		6,660		1,660		

Table VI.

Black clay loam — Summary — Subsurface 6 2/3" - 20"

Soil Area				Total organic carbon		Total nitrogen		Total phosphorus		
No. on map	Name	Number of counties	Number of analyses	lbs. per 2 million		lbs. per 2 million		lbs. per 2 million		Number
6	Middle Ill.	4	12	34,660	±1665	2840	±108	940	± 55	6
7	Upper Ill.	2	2	33,700	±3229	2550	± 93	900	±169	7
8	" "	2	4	45,590	±2085	3680	±976	1420	± 54	8
9	" "	4	5	49,690	± 374	3730	± 57	1370	± 43	9
Mean of Upper Ill.			11	45,290		3500		1300		
10	Early Wis.	4	20	35,620	± 158	3330	± 97	1320	± 24	10
11	" "	7	32	37,600	± 116	3420	± 94	1320	± 45	11
12	" "	4	8	32,990	±1417	3080	±122	1260	± 65	12
Mean of Early Wis.			60	36,330		3340		1310		
13	Late Wis.	2	3	27,870	±3956	2870		1200		13
14	Iowan	None	--	--	--	--		--		14
Mean for type			86	36,130		3200		1250		

Table VII.

Frequency Distribution - Organic Carbon

Surface

	Yellow-gray silt loam											Brown silt loam							Black clay loam		
Soil Area	1	2	3	4	5	6	7	8	9	10	11	6	8	9	10	11	12	13	6	10	11
Values, lbs. per two million																					
0 to 10,000				1																	
10,000 to 20,000	10	6	17	5	3	5	4	2	1	4											
20,000 to 30,000	2	9	6	9	9	9	10	5	10	8	8										
30,000 to 40,000		1		1		1	3	4	4	4	1	3	1						2		
40,000 to 50,000								1			2	12	7	1	12	15	7				
50,000 to 60,000												10	9	11	29	12	13	6	3	4	1
60,000 to 70,000												1		15	12	21	13	6	4	3	11
70,000 to 80,000												1		6	4	7	11	3	2	7	10
80,000 to 90,000														3	1	2	8	7	1	2	5
90,000 to 100,000																1	4			1	1
100,000 to 110,000																	1			2	2
110,000 to 120,000																	1			1	1
120,000 up																	1				

Table VIIa.

Frequency Distribution - Organic Carbon

Subsurface.

	Yellow-gray silt loam											Brown silt loam							Black clay loam		
Soil Area	1	2	3	4	5	6	7	8	9	10	11	6	8	9	10	11	12	13	6	10	11
Values, lbs. per two million																					
0 - 5000			1	1			1														
5000 - 10,000	11	8	19	9	5	9	3	6	9	11	5										
10,000 - 15,000		8	3	6	6	6	9	5	4	4	5										
15,000 - 20,000					1		3	1	2		1		1	1			1	1	1	1	
20,000 - 25,000							1					2			1	3	8	1	1	2	2
25,000 - 30,000												3	3		14	7	13	8	3	4	1
30,000 - 35,000												7	5	5	10	15	13	4	11	3	3
35,000 - 40,000												8	7	11	19	12	8	5	7	2	2
40,000 - 45,000												5	1	6	8	13	7	3	2	4	2
45,000 - 50,000												1		6	6	3	4	1	3	3	2
50,000 - 55,000														6		1	2	1	2		
55,000 - 60,000												1		1					1		
60,000 up																			1	1	

Table VIII.

Frequency Distribution - Nitrogen.

Surface.

	Yellow-gray silt loam											Brown silt loam							Black clay loam		
Soil Area	1	2	3	4	5	6	7	8	9	10	11	6	8	9	10	11	12	13	6	10	11
Values, lbs. per two million																					
0 - 1000																					
1000 - 2000	10	9	20	7	4	7	5	5	2	5	2										
2000 - 3000	2	7	3	8	8	7	11	4	12	9	6	1							1		
3000 - 4000				1		1		3	1	2	2	11	8	1	6	6	2		2		
4000 - 5000											1	14	9	23	39	26	17	3	2		2
5000 - 6000												1		10	9	19	18	11	4	4	5
6000 - 7000														2	3	6	10	3	3	7	9
7000 - 8000																1	3	5		6	8
8000 - 9000																	4	1		2	4
9000 - up																	3	2		1	3

Table VIIIa.

Frequency Distribution - Nitrogen.

Subsurface

	Yellow-gray silt loam											Brown silt loam							Black clay loam		
Soil Area	1	2	3	4	5	6	7	8	9	10	11	6	8	9	10	11	12	13	6	10	11
Values, lbs. per two million																					
0 - 500																					
500 - 1000	7	5	19	11	6	8	5	6	5	4	2										
1000 - 1500	4	9	4	3	4	6	10	4	9	11	7										
1500 - 2000			1		2	2	1	1	2	1	2						1	1			1
2000 - 2500												4	2		7	7	13	3	2	1	
2500 - 3000												13	6	4	18	13	19	10	3	7	10
3000 - 3500												8	6	18	22	26	11	5	5	3	7
3500 - 4000												1	1	10	10	8	7	4	1	7	6
4000 - 4500												1		4	2	2	6				6
4500 - 5000																		2		2	2
5000 - up																					

Table IX.

Frequency Distribution - Phosphorus

Surface

	Yellow-gray silt loam											Brown silt loam							Black clay loam		
Soil Area	1	2	3	4	5	6	7	8	9	10	11	6	8	9	10	11	12	13	6	10	11
Values, lbs. per two million																					
400 - 800	1	10	16	10	8	5	11	7	2	6	2	2			2	2					
800 - 1200	11	6	7	6	4	9	6	5	13	10	8	22	15	24	50	41	18	4	3		2
1200 - 1600						1					1	3	1	12	5	16	29	19	6	1	12
1600 - 2000													1		1		6	2	3	17	12
2000 - 2400																	3			2	5
2400 - 2800																					1

Table IXa
Subsurface

	Yellow-gray silt loam											Brown silt loam							Black clay loam		
Soil Area	1	2	3	4	5	6	7	8	9	10	11	6	8	9	10	11	12	13	6	10	11
400 - 800	1	15	14	14	9	3	14	10	11	13	7	10	6	1	24	20	2	2	4		1
800 - 1200	9	1	9	2	3	12	3	2	4	2	4	15	9	34	34	34	47	20	6	3	12
1200 - 1600	1											2	2	1		2	7	3	2	16	14
1600 - 2000																				1	5

DISCUSSION

"A Study of the Relation between the Soil Type and Chemical Composition."

E. E. DeTurk.

Mr. Bushnall -

"Isn't it true that in the case of the brown silt loam below 6 2/3 inches, it contains soil as black as the surface 6 2/3 inches?"

Dr. DeTurk -

"Yes, that is very true, the uniform brown color extends down 10 to 12 inches."

"If we had a chart in which the comparison showed total organic carbon in the natural soil layer and then compared the natural subsurface layer, for instance, the contrast between the two layers would not be so strong, would it?"

"No, that would disappear, I think. I should judge that the organic matter would drop down far below this value if we took the natural layer."

Dr. DeTurk -

"That sharp contrast would disappear if we took the natural layer."

"Would the same thing apply to the content of calcium? Would the brown subsurface layer show a higher degree of acidity or lesser in brown silt loam?"

Dr. DeTurk -

"We find variations going in both directions. A layer to a depth of 15 inches contains soil carbonate. Nearly always there is carbonate in the till. Some types of brown silt loam contain carbonate in the surface layer and would be called alkali spots. Most of the soils of the surface layer of brown silt loam will grow clover. The Hopkins soil acidity test gives variations from 200 to 800 pounds of lime requirement in the surface soil. Around 600 pounds would be the average."

Dr. Marbut -

"Is the brown silt loam represented by the higher land between here and Danville?"

Dr. DeTurk -

"When we get about half way over there is quite a little timber, but if you exclude the timber area, much of it would be brown silt loam. This corresponds to the Tama silt loam."

Dr. Marbut -

"The Tama is really nothing but loess, it is derived from loess, is rich, and has a well-drained, oxidized subsoil."

"Wouldn't there be any Brookston?"

Dr. Marbut -

"I don't know how the soils of Illinois would run."

ADDRESS

By Charles A. Stanton, President of the Agricultural Appraisal Company.

Mr. Chairman--Ladies and Gentlemen of the American Soil Survey Workers' Association:

In discussing such an important subject as "The Classification of Soils for Commercial Purposes," I think I had better tell you in advance that I am not a soil expert and that I am only an ordinary farm appraiser with the unusual experience of having appraised farm property in nearly every agricultural section of our great country. While that appraisal experience has given me a fair knowledge of soils for practical purposes, yet, I make it a rule never to appraise farm property without the aid of a competent soil man. I believe that the quality and fertility of the soil is our only sound basis for permanent farm land valuation and that a classification of our soils for commercial purposes must be made before we can stabilize our farm land values and better our commercial treatment of farm property. In the discussion of this subject I am going to confine my remarks to the answering of three questions, (1) What is the value of Soil? (2) How can soils be Classified for Commercial Purposes? and (3) Why Should Soils be Classified for Commercial Purposes?

In answering the first question--What is the Value of Soil?--I might tell you that the soil produces everything of material value, or I might tell you that our only two forms of life, namely, plant life and animal life, both owe their existence and maintainance to the soil, but, such facts will not get us anywhere. It would only lead us around a circle and to the Biblical teaching of the fact that "the dust shall return to the earth as it was," which is something we all know. Perhaps the value of soil could best be told in figures showing the billions of dollars produced annually in farm products, but that is statistical and also something we all know. So in answering this question, I am going to refer only to the practical agricultural value of the soil for commercial purposes. To the average man, soil is nothing more than dirt and something that he comes in contact with every day. Excepting the air we breathe and the water we drink, soil is the most common thing we have and the fact that it is so common is where its greatest value lies. Soil is described as being a finely divided rock material mixed with decayed vegetable or animal matter and constituting that portion of the surface of the earth in which all plants grow and fruit. It is not only the home of the plant, but, the machinery that produces the plant and its value exists in its power to produce a plant of value. But the soil alone cannot produce. It must have (1) a satisfactory growing climate and (2) a proper moisture treatment. Climate is something that we cannot regulate, it being an element of nature over which man has no control. So all we can do, and we are doing that very efficiently, is to take the rainfall, temperature and sunshine records for a period of years and determine therefrom a dependable average growing season in every established agricultural section. Moisture for both surface and subsurface soils is something that we can control by either a natural or an artificial drainage system. So the value of the soil can and must be based upon a dependable growing season and a proper moisture treatment. When we know the chemical and physical properties of the soil and its growing season we can easily find its agricultural value and from that agricultural value we can deter-

mine the commercial value. Soil produces by a slow process of nature. Over 95 per cent of our staple crops have only one yield per year. Every line of business has a certain percentage of losses and failures. Nearly all of our mercantile and industrial enterprises have enough turnovers within one year to take care of their losses and failures out of the turnover results of the same year. Such is not the case with the soil where the failure of one crop means the failure of the results of a year. In order to give the value of soil the same consideration given to the value of mercantile and other industrial properties, we must consider the crop results of more than one year, so that a percentage of the crop failures can be established and the average results obtained. It is incorrect to discredit the value of the soil just because it fails to produce a full crop one year or fails completely another year. We must keep in mind the fact that the fertility of the soil can be maintained by fertilizing and rotating and that its proportion of failures to turnovers is not any greater than that of any other business and that the average results during a period of crop turnovers is just as dependable as the average results in any other line of business. Our failure to fully understand this principle is the only reason the value of the soil has not received the same commercial recognition given to other dependable properties. The average investor who thinks only in terms of fixed annual dividends is always ready to condemn the soil when it fails to produce promptly within the year. He does not look beyond the year and does not consider the fact that the soil, like other producing properties, is entitled to its percentage of losses and failures in a given number of turnovers. Had the investing public given the value of soil the consideration of more than one turnover and the full benefit of the average results for a period of years instead of the temporary results of one year, the convertible status of farm property would have long ago b een established and there never would have been any need of the United States Government lending its credit to the farmer. The value of soil must be based upon not less than ten turnovers, which means that we must take into consideration not less than ten crops during a period of ten years. Recognition of this fundamental principle will prove that the soil has a more dependable commercial value than any other thing of material value.

In answering the next question--How can Soils be Classified for Commercial Purposes?--I am mindful of the fact that I am attempting to discuss a subject to which all the members of this Association have given considerable study, and were it not that the soil is so common that it is possible to solve some of its problems by ordinary thought, I would not attempt the task, especially before the largest and best organization of soil men in the world. I shall, therefore, ask you to consider the formula which I am going to offer in answer to this question as being more of a tentative plan for study and improvement rather than a definite solution of the problem. To begin with, there are three things of fundamental importance I shall ask you to keep in mind: First--That the classification of soils for commercial use is not a one-man job, and that it is a business proposition involving the work of man and nature, which in my opinion requires the combined services of four professional men, as follows: The Soil Surveyor, who must determine the different types of soil according to formation, texture, structure, drainage, depth, color, etc.; the Soil Chemist, who must determine the chemical and physical properties in the soil and its agricultural requirements; the Weather Man, who must provide the rainfall, temperature and sunshine records of a given area and determine

therefrom a dependable average growing season for that area and the Statistician, who must find the average prices, yields, costs and failures of the staple crops grown in a given area and determine therefrom the commercial value of each type of soil in that area. Second--That the Classification of Soils for Commercial Purposes must be divided into agricultural districts having uniform geological, topography and climatic conditions. This division is necessary not only because the same soil will produce differently in different growing seasons, but, because the producing power of every type of soil depends entirely upon the growing season. The size of these agricultural districts, which for the benefit of this discussion I will hereafter refer to as "area," may run anywhere from a small valley of a few square miles to a territory covering one or more States. Third--The Classification of Soils for Commercial Purposes must not be regarded as a classification of farm land values since the soil is only a part and not the full value of the farm. The value of the soil represents the productive value from which the full value of the farm is determined by location, improvements, environment, and other governing factors in farm land valuation. Now, my formula for the classification of soils for commercial purposes is substantially this:

(1) We must base the classification upon the following:

  (a) The proper moisture treatment of both surface and subsurface soils either by a natural or an artificial drainage system. (If there should be too much water or not enough water in the soil, it is not the fault of the soil since the remedy, excepting in arid sections that cannot be irrigated, is within the power of the individual.)

  (b) The proper cultivation of the soil for the crop to which it is best adapted. (If the farmer in charge has not the ability nor energy to cultivate the soil properly, the soil should not be held responsible since there are other farmers who can cultivate it properly.)

  (c) The proper development and upkeep of the soil by fertilizing and rotating. (The soil must not only be cleared and kept in good condition to maintain its value, but protected against overflow and other destructive surface elements.)

  (d) The average yield, average price, average cost of production and average percentage of failures for a period of ten years of the principal crop to which the soil is best adapted.

(2) We must analyze every important type of soil and make a business and inventory-like statement of all its physical and chemical properties and characteristics, including its origin, formation, texture, structure, acidity, depth, color, drainage, adaptation and requirements.

(3) We must find the average price, average yield, average cost of production, and average percentage of crop failures of every marketable staple crop in each area for a period of ten years or more.

(4) We must find the soil requirements of every staple crop grown in each area and from these requirements adopt a type of soil for each staple crop, to be used as a standard soil for the classification.

(5) We must multiply the average price of the staple crop by the average yield of the standard soil and deduct from the results the average cost of production and percentage of failures to determine the average annual net income per acre of each standard soil.

(6) We must multiply the average annual net income by ten to determine the commercial value of the standard soil and all the other soils of the area grouped under that standard soil.

(7) We must limit the classification in each area to the number of staple crops grown in the area so that an area having, say, 100 soils and five staple crops will not have more than five standard soils and five different values.

The Classification of Soils for Commercial Purposes is a simple proposition when you understand the fundamental business principles upon which the classification should be made and when you strip the soil of all its unnecessary technical environments and give it a purely business consideration. Of course, we must know the contents and characteristics of the soil to find its full agricultural value, but, when we once determine that agricultural value there is no difficulty in finding the commercial value. There are only three main factors to deal with--Soil, Crop and Climate. Of the three, the Crop is the only factor that has any direct contact with a market value. While the agricultural value of the soil must be determined by its power to produce the crop, yet, the commercial value of the soil must be determined by the value of the crop. For this reason we must group the soils according to crop adaptation. We cannot adapt the soil to the crop and clim ate because that is not entirely practical, and we cannot adapt the climate to the crop and soil because that is not possible. But we can adapt the crop to the soil and climate, and in order to do this efficiently we must find the soil required for each staple crop and use that soil as a standard for the classification. According to the Bureau of Soil Bulletin No. 96 there were 1,650 types of soils in the United States recognized up to 1912, which number has probably been increased to about 2,000 since that time. According to the 1920 census report, we have in the United States approximately 503,000,000 acres of tillable soil under cultivation. Of this acreage we have approximately 350,000,000 acres in five crops--corn, wheat, hay, oats and cotton, and approximately 50,000,000 acres in nine crops--barley, rye, tobacco, potatoes, rice, peanuts, cane, beets and buckwheat. The remaining acreage, approximately 103,000,000 acres, is divided into more than 200 varieties of fruit and vegetable crops. So in the classification of approximately 2,000 types of soil in the United States we have for our first consideration five big important crops covering about 70 per cent of the acreage, for our second consideration nine less important crops covering about 10 per cent of the acreage, and for our last consideration the 200 small remaining crops covering about 20 per cent of the acreage. This means that the first five and next nine staple crops will dominate the classification and limit all the soils in the United States to fourteen basic values. Of these fourteen it is not likely that

there will be more than six or seven values in any one area. In the early part of this year the A gricultural Appraisal Company of Columbus, Ohio, undertook the classification of the soils in Ohio for commercial appraisal work. Up to the present time we have recognized 155 soil types which we have grouped into six different basic values. All the organic and bottom soils have been placed in one group and valued at $100 per acre, which is the highest value in the classification, and all the inorganic and upland soils have been placed in five groups with five values running from $40 to $85 per acre. Our success in bringing all the soils of the State into one general classification has been due largely to the fact that Ohio happens to have a uniform condition with respect to both climate and soil texture. With the exception of a slight difference in the temperature of the lake counties on the north and the river counties on the south, the growing climate is practically the same all over the State, and with the exception of a few small areas of heavy clay and sand practically all the soils in the State are silt loams or silty clay loams. As we proceed in the development of our detail classification by counties like the Marion County Classification, it is very probable that we will have to divide the State into two classification areas. If we do this it will be entirely for geological reasons, since the State happens to be in three important soil provinces, namely, the Glacial Drift, the Glacial Lake, and the Appalachian Plateaus. The division will probably bring all the glacial and limestone soils of the lake counties and the northwestern half of the State into one classification area and all the non-glacial and shale and sandstone soils of the river counties and southeastern half of the State into another classification area. If we divide Ohio into these two areas, which I am sure we will have to do, and we take the climatic and geological formation of these two areas as our guide for a national classification, the estimated number of areas that will be required to make a complete classification of all the soils of the United States will be as follows:

REGION OR PROVINCE	COVERING
(1) Pacific Coast Region. 15 Areas	All of the Pacific Coast States west of the Cascades, Sierra Navada and San Bernardino Mountain ranges.
(2) Northwest Intermountain and Great Basin Regions. 11 Areas.	Eastern Oregon, eastern Washington, southern Idaho, western Utah, southeastern California, and all of Nevada.
(3) Southwest and Arid Regions. 3 Areas.	The extreme southeastern corner of California, southern Arizona, southern New Mexico and that portion of Texas south of New Mexico.
(4) Rocky Mountain Region. 20 Areas	Northern Idaho, western Montana, western Wyoming, eastern Utah, western Colorado, northern Arizona and northern New Mexico.

(5) Great Plains Region. 6 Areas	(Southeastern Montana, eastern Wyoming, eastern Colorado, eastern New Mexico, southwestern North Dakota, western South Dakota, western Oklahoma, northwestern Texas, and practically all of Kansas and Nebraska.
(6) Glacial Lake Provinces. 5 Areas.	(Red River Valley of North Dakota and Minnesota and small areas in States bordering the Great Lakes.
(7) Glacial and Loessial Provinces. 17 Areas.	(Eastern parts of the Dakotas, eastern Nebraska, practically all of Minnesota, Wisconsin, Iowa, Illinois, Michigan, Indiana, western and northern Ohio, all of New York excepting the Lake Counties, northern Missouri, northeastern corner of Kansas, all of the New England States, northeastern Pennsylvania, and the western parts of Kentucky, Tennesee and Mississippi bordering the Mississippi Valley.
(8) Limestone Valleys and Upland Provinces. 5 Areas.	(Central and western Kentucky, central and eastern Tennessee, and a narrow strip of territory running from northeastern Alabama to southeastern Pennsylvania, northern Arkansas and southern Missouri.
(9) Appalachian Mountain and Plateau Provinces. 5 Areas.	(Greater part of Pennsylvania, southeastern Ohio, all of West Virginia, eastern Kentucky and western North Carolina.
(10) Piedmont Plateau Provinces. 4 Areas.	(Northern New Jersey, southeastern Pennsylvania, northern Maryland, western Virginia, central North Carolina, northwestern South Carolina, northern Georgia, and a small part of eastern Alabama.
(11) Atlantic and Gulf Coastal Plains Provinces. 12 Areas.	(Southern Arkansas, eastern, southeastern, and southwestern Texas, all of Louisiana excepting the Mississippi Delta, all of Florida, all of Delaware, eastern Mississippi and the southern parts of Alabama, Georgia, Virginia, Maryland, New Jersey and the Carolinas.
(12) River Flood Provinces. 2 Areas.	(Mississippi Delta in Arkansas and Louisiana.

In all there will be not less than 105 classification areas in the United States, and all the soils in each area will be limited to fourteen groups and fourteen basic values. About 80 per cent of these areas will not require more than six groups and six basic values, which is the present limitation of our Ohio classification.

I will now proceed to answer the last question, Why Should Soils be Classified for Commercial Purposes? In answering this question I am going to direct your attention to the farm land situation of our country and tell you why I believe our modern farm land problems cannot be entirely and successfully solved until we classify our soils for commercial purposes. Fifty years ago we had plenty of free government land and an undeveloped West to draw upon for our surplus population. In those days a horse could be traded for a farm and there was no need of any commercial recognition of soils. Today the situation is quite different. All of our best agricultural lands are privately owned and our population--exceeding 110,000,000--is now growing at the rate of 1,500,000 people per year. The time has come, therefore, when we must take stock of our resources and figure on the future distribution of our rapidly growing population. As matters stand today, about 40 per cent of the farmers of the United States are tenants and this percentage is increasing every year, which means that we are gradually drifting towards a peasantry condition, that is contrary to the basic principles of our great Republic. Now, regardless of all that we have done or may do by legislation or otherwise, we cannot ignore the fact that the future distribution and settlement of our farm lands is a purely private commercial proposition. This means that we must not only have a better commercial treatment of farm property, but base that commercial treatment upon a constructive land settlement policy that will promote farm ownership upon terms and conditions that are commensurate with the character and fundamental purposes of our basic industry. Easy opportunity for farm ownership which started and ended with the final distribution of our best public lands must be continued today in a commercial form, otherwise we will not be able to maintain our farming population and our high standard of modern farm life. In other words, if we expect to maintain our productive population we must give the man who cultivates the soil an opportunity to buy a farm under conditions and terms that will enable him to remain on the farm and become a farm owner by his own labor. How to accomplish this with safety to the investor and satisfaction to the farmer is the problem before us. I claim that it can be accomplished and that it will prove a good business proposition when we classify our soils for general commercial use and develop the convertible status of farm property. The apparent simplicity of our farming operations, leading everybody to believe that they know as much and more than the other fellow about soil fertility and farming generally, is the underlying disturbing influence of our whole farm land situation. As a matter of fact we all think we know so much when we know so little about soil and farming that we necessarily follow the temporary results before us instead of the general and permanent results that should govern farmland valuation. The average investor gets his idea of the value of a farm from either an isolated experience of his own or from the experience of those near him. He does not stop to consider the fact that all our crop failures, crop fluctuation, labor troubles and other difficulties in farming operations are not any greater than the difficulties of our best-organized industries. The absence of a recognized standard for farm-land valuation, which is possible only by a classification of our soils for commercial purposes, is the very reason why every investor and even our govern-

mental agencies are obliged to fix farm-land values differently for their own purpose and protection. Appraising farms by various methods without any regard for the fundamental purposes of our farming industry is largely responsible for most of our farm-land difficulties and the main cause of all our unnecessary speculation and fluctuation in farm-land values. The remedy is not in an organized market for the sale of farms or the expansion of land credit. It is in a recognized basis for farm-land valuation by which we can develop the convertible status of farm land and give the farmer an opportunity to improve his financial standing and better his methods of doing business. Our present methods, unfortunately, are more of a peasantry treatment than a business enterprise. The average farmer is more concerned in the recognized value of his farm, which enables him to control his credit and protect his equity savings, than he is in the credit itself. When we hear of farm-land values going up or down because of some activity in the sale of farms, or in the sale of farm products, we should stop and investigate the cause of that activity before accepting it as a natural increase or decrease in farm-land values. While the demand is an important factor in any commercial valuation, yet in the valuation of farm land we must not overlook these facts:--(1) That farm land has a permanent economic value and is not a consumed product; (2) that our soil area will never increase while our population will always increase; (3) that it is the slow growth of our farming population that should regulate the demand for farms and not our speculative and widely fluctuating prices of farm products; and (4) that a farm is as much a home as it is a business and that these two factors must be given full consideration. Failure to sell farms under our existing practice does not always mean that there is no demand for farms since our present selling methods are not within the reach of the so-called "dirt" farmer or the man who tills the soil. Selling farms for cash or upon short terms is all right for the few who have succeeded in saving their earnings for that purpose, but not fair to the many who have not been able to save and who want that opportunity for saving while engaged in farming. A real estate operator recently told me that only one man out of five who wanted to buy farms and engage in farming was able to meet his selling requirements, notwithstanding his offer of the Government long-time credit up to 50 per cent of the land and 20 per cent of the improvements. The experience of this real estate man is typical of the situation in every agricultural section. There are plenty of people qualified for farming who would buy farms were the right opportunity for purchase open to them. The incentive to own a home is the thing that will move the average man to work and become a better citizen. That incentive must be encouraged and promoted in the country as well as the city. In a farm we have both the home and business of the man who cultivates the soil, but unlike the man in the city, the man on the farm must own his business in order to own his home. The dollar-down-and-dollar-a-week principle which has done so much to promote home ownership in our cities and industrial centers, must also be used to promote farm ownership in our rural sections, although the application of that principle to a proposition which involves both the home and business of the individual calls for a different and better commercial treatment than that given to city property. The value of a city lot is based entirely upon location, while the value of farm land is based upon the fertility of the soil in addition to location. Determining a value by location is a simple mathematical proposition, but determining a value by the fertility of the soil is another matter. I claim that as soon as we classify our soils for commercial purposes and stabilize our farm land values, we can then develop a

better commercial treatment of farm property and solve the problem of farm ownership for the man who cultivates the soil. It matters not how constructive the plan of operation may be for the settlement of new lands or for the resettlement or development of established farming communities, we cannot get away from the fact that it is the quality and fertility of the soil that governs the situation. The solution of the whole farm-land problem, in my opinion, depends largely, if not entirely, upon a better understanding of soil fertility and farm work. We do not, I am sorry to say, properly appreciate modern farming and the wonderful possibilities it offers today. A few generations ago work on the farm represented 100 per cent manual labor and about 25 per cent of the then known comforts of life. Today, when 75 per cent of the work on the farm can be done by machinery, the situation is reversed. Farming now represents 25 per cent manual labor and about 100 per cent of our existing comforts of life. A few months ago a labor expert and I figured that the man who played golf one-half of the year for exercise actually spent more physical energy than the man who cultivates forty acres of land under modern conditions. We also figured that King Solomon in all his glory and all the kings and potentates from his time down to our present generation never had all the living advantages, comforts and enjoyments in life that are today open to the average American farmer. And yet the American farm is not producing one-half of what it is capable of producing. It is not being improved for the permanent use it offers. It is not given the commercial treatment it is entitled to. And it is not understood and appreciated as it should be. There is plenty of room for improvement. All the progress made since the days of the spindle, scythe and ox team is not one-fourth of the progress that is yet to come. The tractor, automobile, and highway, electricity, radio and other modern conveniences are rapidly revolutionizing American country life and making it the best the world has ever known. The isolated farm is rapidly passing away and the farmer who has the ability and energy to take advantage of all the opportunities open to him is going to enjoy a contented life of happiness and prosperity that has no equal. There are just two things we must do, and they are: (1) Promote public confidence in farm land values, and (2) educate the people to a better understanding of farm work and farm life. To do these things we must know more about the soil. That is why we should classify our soils for commercial purposes. Thank you.

DISCUSSION.

Classification of Soils for Commercial Purposes - Charles A. Stanton

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"I would like to ask how your appraisal value compares with the selling price in Ohio."

Mr. Stanton -

"At the present time it runs a little bit more, but we pay no attention to the selling prices of farms."

SOIL STUDIES IN MICHIGAN

By M. M. McCool and J. O. Veatch.

The paper here presented contains in a brief and preliminary way the results (both theories and facts) of field and laboratory study in soil morphology and soil geography for the State of Michigan during the past year. This work constitutes a part of the research which the Soils Section of the Michigan Agricultural Experiment Station is conducting in connection with the Soil Survey work in the State. The writers are firm in the belief that work of this nature should precede or go hand in hand with the detailed studies, since by so doing the work as a whole may be closely correlated. Our work has been in a large measure an attempt to apply the concepts and observations of the Russion podologist, Glinka, and other European investigators, and those of Dr. C. F. Marbut of the U. S. Bureau of Soils. These are in essence: soils in their broader features are a function of climate; the soil is a separate entity and is capable of being classified on the basis of its own intrinsic characteristics; the proper study of soils should proceed by means of profile analysis, the determination of the separate members, horizons, for the whole soil thickness, the arrangement, physical characteristics and composition of each.

In an extensive reconnaissance, observations were made from the extreme southern to the northern end of the State. The observations were restricted mainly to virgin soils while the complete profile or whole thickness of soil weathering, from the surface to the practically unaltered geologic substratum, was taken into consideration. In collecting samples, these were taken to represent the different horizons present, whatever their thickness or depth. Arbitrary distinctions as to soil and subsoil and the method of collecting samples according to fixed depths or at fixed intervals were discarded from the outset as being unsuitable for the purposes of these studies, since the primary object was to determine whether it might be practicable in soil classification work to recognize separate horizons and whether these possess physical and chemical qualities which are constant in a general way. Observations were necessarily confined to relatively mature or old soils.

On the basis of our work, so far as conducted, we believe that two broad groups of the rank of climatic soil provinces should be recognized in the State. For the present we are designating these simply as: (1) Northern group and (2) Southern group.

The comparisonal description of these two groups is briefly presented. The profile of the soils of the Northern group consists of the following horizons which appear to be universally present but variously modified by texture, topography, vegetation and nature of the parent inorganic material or geologic base.

1. Surface horizon of forest mold.

2. Gray or ashy soil - the podsolized horizon.

3. Brown horizon-color and peculiar character due mainly to colloidal organic matter.

4. Horizon of inorganic soil showing variable degrees of iron oxide coloring.

5. Substratum or geologic formation.

True humus soil is practically absent or attains only a minute thickness; the surface mineral soil is gray; there is a relatively sharp line of separation between horizons 1 and 2 and 2 and 3.

The profile of the Southern group is:

1. Horizon of mold and humus soil.

2. Horizon of brownish and yellowish soil.

3. Horizon of maximum clay and maximum intensity of coloring from iron oxide.

4. Gradational soil of small thickness, showing decrease in colloidal matter and decrease in iron-oxide coloring; layer of small thickness.

5. Geologic substratum.

The surface mineral soil is brownish; the gray and brown horizons of the Northern soils are only faintly developed or are entirely absent; a horizon of maximum clay, which possibly represents colloidal concentration, No. 3, is more strongly developed and the horizons are not as sharply separated from each other as in the Northern group.

Chemical and physical laboratory determinations of samples from representative profiles for the two major soil groups are given in the accompanying table.

On the basis of these analytical results and of a large number of other determinations which are not given here because partial and incomplete, it appears that the following generalizations might hold. For the Northern group, the silica is markedly higher in the gray (podsolozied) horizon than in the brown horizon; the iron and alumina together are markedly higher in the brown horizon than in the gray horizon; the nitrogen is highest in the surface horizon, thence there is a decrease in the gray horizon, followed by an increase in the brown horizon or at least no appreciable decrease. In the Southern group it appears that there is a gradual decrease in nitrogen from the surface downward.

In both the Northern and Southern groups the humus soil (excluding leaf litter and raw forest mold) and the substratum show the higher pH or lesser degree of acidity than the intermediate horizons. In neither province is there any certain evidence of a consistent gradual increase in pH with depth. In the Northern Group where the brown horizon is conspicuously marked the pH generally reaches the lowest point. In the Southern Group the lowest pH in certain profiles which have the horizon of clay concentration strongly developed, may be within a leached horizon of small thickness resting directly upon the clay. In general it appears that there is an increase in total bases with

depth from the surface, but that this is not a constant gradual increase.

It is doubtless true that the soil expresses its physical characteristics quite well by its behavior toward water. Such characteristics as texture, structure, amount of colloidal matter and organic matter, activation of surface of soil particles and other things tend to reveal themselves, by such behavior. The phenomena of the heat of wetting and unfree water are in the m ain the resultant and expression of these characteristics. Now, if such is the case and if the soils of the Northern and Southern Groups are different with respect to their horizons, it logically follows that investigations of their values for heat of wetting and unfree water should reveal them to be different.

These values, for a large number of horizons from each group, have been obtained. They bring out that the sand soils in the Northern Group have the highest heat of wetting and unfree water in the first horizon; they are low for the gray horizon while for the brown horizon they are considerably higher than for the gray. With respect to the sand soils of the Southern Group these values are highest for the surface horizon thence show a constant decrease in the lower horizons. However, in the Southern Group there may be also a marked increase in the heat of wetting in a subsurface horizon, the horizon of maximum clay, but this is not at all omparable to the brown horizon of the Northern soils.

To summarize it is our opinion that the separate horizons, of the profiles, which can be differentiated in the field, will be found each to possess peculiar physical and chemical characteristics. It follows that their recognition cannot be ignored in soil classification.

Possibly further field studies and analytical work on a greater number of samples may not uphold in entirety the conslusions here presented. However, it is felt that investigational work of this nature is of fundamental importance in working out a sound scientific system of soil classification.

SOUTHERN GROUP

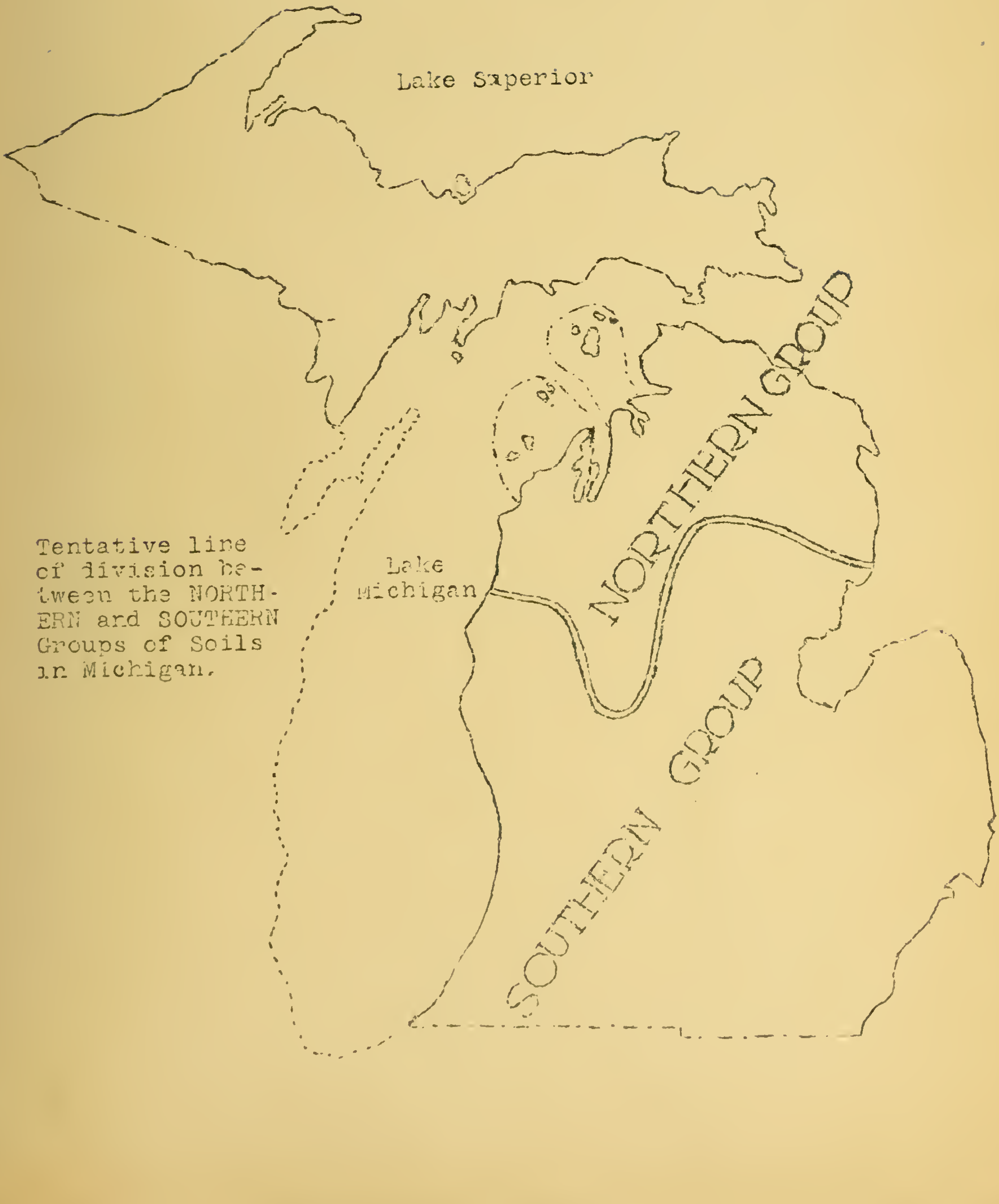
Horizon	SiO2	FeAl	Sum bases	CaO	N	pH	Heat Wetting*	Unfree Water Per cent	Silt Clay	Soil Description
1	86.38	2.41	2.14	.34	.24	4.82	109.32	2.7		Sand - good
2	89.28	4.88	2.18	.44	.05	4.43	49.96	1.4		drainage
3	91.92	4.74	1.92	.49	.02	5.33	20.53	0.8		Coloma
4	92.96	4.67	2.15	.46	.00	4.94	17.29	0.8		Berrien County
1	90.47	6.09	3.07	.98	.17	6.73	94.25	2.2		Sand - good
2	92.73	6.15	2.25	.61	.03	5.95	50.[illegible]	.9		drainage
3	92.98	5.83	2.47	.65	.02	5.93	37.58	.7		Ottawa
4	92.27	4.53	2.36	.49	.01	5.92	24.17	1.1		Scottville
1	88.15	3.83	1.67	.49	.10	5.60	62.62	1.8		Sand - good
2	92.99	3.78	1.64	.34	.04	4.58	38.54	1.3	6.7	drainage
3	91.97	4.38	2.01	.38	.03	4.65	40.55	1.1	4.3	Plainfield
4	96.22	4.09	1.85	.42	.00	4.94	17.90	1.1	3.1	Grayling
Sub					.01	5.63	10.39	0.4		
1	78.51	9.14	3.59	1.08	.27	6.32				Loam - good
2	80.78	9.52	3.49	.76	.05	5.43				drainage
3	77.91	12.95	3.80	.91	.03	5.19				Bellefontaine
4	76.39	14.19	3.92	.90	.01	5.33				Kalamazoo

* Calories of heat produced per 50 grams of soil.

Northorn Group

Horizon	SiO$_2$	FeAl	Sum bases	CaO	N	pH	Heat Wetting*	Unfree water Per cent	Silt clay	Soil Description
1	85.50	2.49	1.53	0.59	.28	5.60	153.0	3.3		
2	94.92	1.59	1.24	.24	.02	4.58	20.6	.8		
3	90.40	4.39	1.94	.32	.07	4.65	69.8	1.5		
4	89.88	4.42	2.15	.46	.05	4.94	59.8	1.2		
Sub					.00	5.63				
1	74.69	4.30	2.02	0.63	.47	5.06	155.35	4.5		
2	93.34	2.35	1.61	0.27	.01	4.89	16.82	.7		
3	86.64	5.24	2.71	0.36	.06	4.48	140.03	1.4		
4	89.97	2.97	2.62	0.28	.01	4.82	28.87	.8		
Sub						5.28				
1	68.04	6.16	2.78	2.24	.65	7.46				
2	86.96	4.41	3.09	.62	.04	6.41	48.13		37.5	
3	86.18	6.17	2.87	.69	.04	5.14	62.14		21.7	
4	69.59	8.53	8.58	6.22	.03	7.47	65.05		30.5	
Sub					.02	8.25	28.83		25.7	

* Calories of heat produced per 50 grams of soil.



Tentative line of division between the NORTHERN and SOUTHERN Groups of Soils in Michigan.

DISCUSSION

Physical and Chemical Investigations on Several Soil Types of Michigan - M. M. McCool.

Dr. Marbut -

"I am very glad indeed to see that work done. I think that is the first work of the kind to be done in the United States. I am also very glad to get this division line between the northern and southern groups of soils in Michigan."

THE CONDITION OF SOIL SURVEY WORK IN RUSSIA TOWARD THE BEGINNING OF THE YEAR OF 1923

By Prof. N. M. Tulaikov, President of The Russian Institute of Experimental Agronomy.

The question of necessity of studying the soil layer of Russia was first raised in the middle of the 19th century, and a certain portion of the work in this direction was made, basing on the data of various kinds of statistical and economic investigations that were available at the time. The question of soil survey in Russia attracted the foremost interest, so fas as scientific soil investigations are concerned, after the study of Russian chernozem by Prof. V. V. Dokuchaeff, who was the first one to make an exceptionally thorough study of this most important soil type. In the eighties of the last century, Prof. Dokuchaeff was invited by Nijnegorodsky Zemstvo to make a soil survey of Nijnegorodsky province. This work, classical in its value from all points of view, made it possible to prepare a group of the most noted soil men in Russia (Professors Sibertseff, Ototsky, Zemiatchensky, etc.) who later founded the so-called "Dokuchaeff school of soil investigations".

These men have done a tremendous amount of soil survey in the spirit of this school and played a very important role in the development of the soil survey in Russia. The basic thesis of the work of this school among Russian soil survey men consists in the thought that soil is a natural formation, which in its characteristics reflects all those natural conditions in which the formation took place. Taking for a basis a fact that the distribution of soils over the Russian plains so well coincides with the geological, climatic, and topographical peculiarities and the age of each region, Prof. Dokuchaeff and his followers, especially Prof. Sibirtseff, have developed a natural classification of soils of European Russia. (The basic idea of this classification, as well as the classification itself, was discussed by the author in an article in the Journal of Agricultural Science, Vol. 3, p. 1, pp. 80-85). This classification was afterwards adopted in all soil survey work and gave a large amount of data for further investigation and also for the development and the perfection of this classification.

The soil survey of Russia shows that, different in their characteristics, soils are situated in European Russia in the form of wide belts running from the west towards the east in the latitudinal direction and to a certain extent in parallel with the natural vegetation in European Russia. The extreme north portion of European Russia is occupied by tundra with the ever frozen subsoil, capable to support but a scanty northern vegetation and having practically no agricultural value. Further toward the south, in the forest region of northern Russia, lie northern podzols of morainal origin, which still further towards the south grade themselves into chernozem. Chernozem spreads as a wide belt, having the after-morainal loess for a subsoil. It has a characteristically prairie vegetation and by itself characterizes the Russian plains (prairies). In the extreme south and especially in the south-eastern portion of European Russia, chernozem changes into soils with smaller amounts of humus and with greater amounts of easily soluble salts. These are light gray soils of dry prairies and deserts,

Of course, these basic types of soils of Russian plains are united by a multitude of transitional formations that characterize the respective transitional conditions of their formation - the types from which they originated, topography of the region, etc.

On further and more detailed study each soil type is subdivided according to its mechanical composition into a series of variations of heavier types or clay soils and lighter types or sandy soils, with all possible gradations between these two extremes.

In the eastern portion of European Russia, several provinces were surveyed by Prof. Rizpolojensky of Kazan University, who applied a somewhat different soil classification, but the area of this kind of soil survey is relatively small.

In 1901, the Department of Agriculture published a soil map of European Russia, making for a basis the data available at the time. The map was prepared under a supervision of Prof. Sibirtseff and Ferhlit, using Prof. Sibirtseff's classification and having a scale of 60 verst to one inch. (One English mile equals approximately 1.5 verst). This soil map has played a very important role in studying and in evaluation of soils of European Russia. Soon after this, partly due to the enactment of a law regarding the evaluation of lands for the purpose of a more correct property taxation, many local Zemstvos began a systematic and detailed soil survey in different provinces of Russia and during the period between 1903 and 1914 soil survey covered a greater portion of the territory of European Russia.

A wave of immigration to Siberia caused Russian scientists to start investigations of soils of the vast Siberian territories. The soil survey proper was started in Siberia in 1908 by Prof. Glinka and was stopped just before the war. The soil survey in Siberia has been done, not on the whole Siberian territory, but only in many specially selected regions of some agricultural importance. This soil survey made it possible for Prof. Glinka to make a schematic soil map of Siberia which was printed in connection with his well known book onn"Soils".

The soil survey of European Russia was made in detail, relatively speaking, and the soil maps were prepared, depending on the degree of accuracy, with the scale of 3 versts to the inch, sometimes 2 versts to the inch and even 1 verst to an inch, (Chernigov province). Often the survey was not of a very detailed character and the scale of mapping was as small as 10 verst to one inch. At the present time nearly the entire area of European Russia, with the exception of tundra and the northern forest area, is surveyed, and all of this vast amount of material is being classified and unified in the preparation of a new soil map of European Russia, in which case the scale to be used 1/1,000,000, i. e. approximately 23 versts to an inch (the scale adopted for the publication of maps in accordance with the international agreement). This work is being done in cooperation by Dokuchaeff's Soil Committee, Soil Committee at Russian Academy of Science, and other scientific institutions and individual soil survey men, under whose supervision the soil survey has been done in various provinces. The map will be completed in the very near future. It will summarize the soil survey in European Russia and give a better and up to date picture of Russian soils, distributing the different soil types over the Russian territory.

Besides the general soil map mentioned above, Prof. Prasoloff, Director of the Bureau of Soils of the Agricultural Scientific Committee, has prepared a map of soil regions (scale 60 verst to one inch). This map shows not the individual soil types, but only a combination of soil types with the similar characteristics as to climate, topography and vegetation. The map is accompanied by a description of those regions as to their geographic character, composition of soils, their character, agricultural value, etc. An estimate is made of the total area of each regional type and other valuable material is included that gives a general outlook on the soil peculiarities of a given region. This work is ready for publication but it is not yet published.

There are two main agencies for the geographic study of Russian soils, namely: Dokuchaeff Soil Committee in Petrograd, and Moscow Soil Committee in Moscow. Each of these committees in these two most important Russian centers has on its staff several soil survey men with numerous field assistants. The same general program is followed by both institutions and the same general methods are employed by both in field and laboratories. Each institution is supported by the Government, at whose request, for instance, the entire soil survey in Siberia was made by the Dokuchaeff Soil Committee. Each committee has laboratories for both physical and chemical soil analysis and each institution has pyblished a soil journal. Dokuchaeff Soil Committee has published a journal, "Soil Science" (Pochvovedenie) since 1900 to 1914. The publication ceased at the beginning of the war and has not yet been renewed. The Moscow Soil Committe is publishing a journal, "Russian Soil Man" which was stopped during the war, but made its appearance again during 1922. (The author brought several recent issues to this country for Dr. J. G. Lipman, as an editor of Soil Science).

Before the war Russian soil survey men had held several national and local conferences for the discussion of questions pertaining to the methods of soil survey both from theoretical and technical points of view in order to further unify the procedure of the soil survey. In the fall of 1921 in Moscow, a third national conference of soil survey men took place where several very important questions were discussed in connection with the continuation of the soil survey in the newer regions. The question of publishing a new soil map was discussed at the meeting. Also a question was raised regarding the more systematic soil investigations of different soil types at different experiment stations in order to establish a connection between the various soil types and their agricultural values.

A clear and logical dependence between the natural conditions and the soil types found under those conditions, which is so well revealed in the soils of Russian plains, made it possible to develop a very simple and yet scientific soil classification that was adopted by other countries (for instance Roumania). It would be very interesting and important in order to develop a general and natural classification of soils of the entire surface of the earth that another great country, namely, the United States of America, would take a more active part in critically studying the Russian soil classification as well as the general literature on soil investigations in Russia. There are many reasons for the thought that there is a very great similarity between the soils of Russia and those of the United States, for in their modification from the natural soil conditions, man has accomplished relatively but little. The parallelism between soils of the United States and those of Russia is evident to every one who is more or

less familiar with this kind of work, and we may hope that by the cooperative efforts of American and Russian soil survey men it would be possible to develop such a soil classification that would be adopted by science in general, similarly to classifications of plants and animals which are used by all workers in zoology or botany.

The corner stones of this classification, it seems to me, have been laid already by some soil scientists. It remains for all soil investigators, submitting all available data to a thorough analysis and investigation, cooperatively to further this work to the fullest extent that is made possible by the available materials on this subject. The role of American and Russian soil investigators in this respect will naturally be the greatest, and to their lot it may fall the honor of being the pioneers in developing a scientific soil classification.

Progress of Soil Survey in Ontario.

By Prof. R. Harcourt, Ontario Agricultural College.

Work was commenced in the reconnaissance survey of the soils of the older part of the Province in the summer of 1914. The work was continued with many interruptions and changes in the surveying staff due to the war, during the next four years. In 1919 we succeeded in completing the survey and gathering up all the loose ends due to the interruptions, but unfortunately the man who did the final work fell a victim to the "Flu" before he had a chance to write up the work. From his notes and maps we have prepared our first publication and this is now practically ready for publication.

During the summers of 1920 and 1921 no survey work was done, as it was impossible to secure a trained man for the work. This season we were able to start the detail, survey and we intend to develop the work as fast as we can.

Based on our reconnaissance survey we have laid out three experimental plots on three of the larger series of soils. From one of these we have had five crops, another three crops, and the third was only got under way the past season.

As will be seen our work has been very much broken, but we hope to make better progress in the future.

SECRETARY'S REPORT

AMERICAN ASSOCIATION OF SOIL SURVEY WORKERS.
From November 19, 1921 to November 17, 1922.

The activities of the Association during the past year have been directed chiefly to the publication of Bulletin No. 3 which was a report of the second annual conference of the Association held at East Lansing, Michigan, November 18 and 19, 1921. This report consisted of ninety-one pages and three hundred complete copies were issued. The Secretary wishes to state that the stencils for this report were all cut by the office of the U. S. Bureau of Soils at Washington, D. C., and the paper, mimeograph machine, labor and etc., in running off the copies were supplied by the University of Wisconsin, College of Agriculture. For all of this work and service there was no charge made. The copies of the Bulletin were mailed out in March 1922 to all members and to about one hundred fifty others who are interested in our work.

Two hundred copies of Bulletin No. 2 were sold to the Oklahoma Agricultural College and several other small shipments of from ten to fifty each were made to other soil workers who were not previously supplied. The Secretary still has on hand about twelve hundred copies of Bulletin No. 2. It has been our practice to supply without cost about one hundred copies of these to Colleges desiring them; where more than this number are desired, we have been quoting a price of $3 per hundred or $25 per thousand.

MEMBERSHIP

At the time of the annual meeting in 1921 there were one hundred thirty-six members. At the present time the Association has one hundred sixty-eight members and these are distributed among thirty-five states and nine Canadian provinces, in addition we have one member in the Philippine Islands and one member in India. We also have a request from a soil worker in Norway asking if he is eligible for membership. A soil worker in Australia has shown much interest in our Association and may wish to become a member. The Secretary wishes to suggest that the Association should take some action relative to admitting workers from foreign countries to membership in the Association.

THE AMERICAN ASSOCIATION OF SOIL
SURVEY WORKERS.

(Signed) W. J. Geib.

Approved Nov.17, 1922. Secretary-Treasurer.

TREASURER'S REPORT

AMERICAN ASSOCIATION OF SOIL SURVEY WORKERS COVERING THE YEAR NOV. 19, 1921 to NOV. 17, 1922.

RECEIPTS:

1921		
Nov. 19.	Balance on hand from 1920	$49.02
Nov. 19.	Dues for 1922 collected prior to this date.	68.00
Nov. 19	Total cash on hand	$117.02
Nov. 19-21 to Nov.1-22.	Additional dues for the year 1922	76.30
	Total	$193.32

EXPENDITURES:

		Voucher	
Nov. 30-21.	Printing on badges	1	$ 4.00
Nov. 30	Zinc etching "	2	2.82
Mar. 16-22	Stapling Reports	3	5.00
Mar. 18-22	Zinc etching	4	5.10
June 6	Binding annual Reports	5	1,50
Aug. 14	Stamps	6	15.00
Oct. 10	Stenographic work		2.50
Oct. 21	Stamps	7	14.51
Oct. 22	Zinc etching-programs	8	2.50
Oct. 23	Printing programs	9	23.00
Nov. 12	Telegrams		2.30
	Total		78.23

Total receipts for 1922	$ 193.32
Expenditures	78.23
Balance on hand for 1922	$ 115.09
Dues collected for 1923	46.00
Total amount in Treasury on Nov. 17, 1922	$ 161.09

Money outstanding. Sold to Oklahoma Agri. College 200 copies of Bul. No. 2 at $3.00 per 100 total due $6.00

THE AMERICAN ASSOCIATION OF SOIL
SURVEY WORKERS.

(Signed) W. J. Geib.
Secretary-Treasurer.

MINUTES OF THE BUSINESS MEETING OF THE AMERICAN ASSOCIATION OF SOIL SURVEY WORKERS
HELD AT URBANA, ILLINOIS, NOVEMBER 17 & 18, 1922.

The meeting was called to order by President Wianko in the Union Building at Urbana, Illinois, Friday night, Nov. 17, 1922.

Minutes of the previous meeting held at East Lansing, Michigan were read and approved.

Report of the Secretary-Treasurer read and accepted.

The Steering Committee of which M. F. Miller was chairman nominated the following officers for the coming year: President, F. J. Alway; Vice-President, M. M. McCool; Secretary-Treasurer, A. M. O'Neal.

The Secretary was instructed by vote of the Association to cast the unanimous ballot of the conference for the officers nominated. Those nominated were declared elected.

The Committee recommended that the new President continue all standing committees with such changes as seem desirable. Following the action of the Association, they recommended that the Committee on Soil Maps and Reports be made into two Committees, one on Soil Reports and one on Soil Maps and that a new committee on Terminology be appointed.

The Committee recommended that the next meeting consider the following subjects:

1. The relation of our Soil Survey to Land Classification.

2. Methods of Sampling.

3. Relation of Soil Acidity Tests to Classification.

4. It suggests the policy of encouraging the development of experimental fields by soil tests.

5. It recommended that the A ssociation should encourage the more intensive work in the individual states regarding "Characteristics of Soil Profile".

The time and place of the next meeting were left to be decided by the Executive Committee in the hope that the Agronomy Society might meet at some point in the Central West so that the Soil Association might meet at the same place.

The Committee on Resolutions consisting of G. E. Condra and P. E. Brown presented their report relative to the death of Professor Mosier. The motion was made that these resolutions be spread on the Minutes of the Association and that copies be sent to the bereaved family and to the University of Illinois.

The Association paused in its deliberations to pay silent tribute to the

memory of Dr. C. G. Hopkins.

The Association went on record as favoring the Temple Bill which is now pending before Congress and which provides for topographic maps which will complete the United States in about twenty years. The Association urged that the individual members of the Association take such action as they could in informing their Congressmen of the importance of having this work completed earlier. The Secretary was instructed to notify the Federal American Engineering Society at 26 Jackson Place of the action of the Association.

The Association expressed appreciation to Miss Nagel for her splendid work in taking stenographic record of the various discussions. She was presented with a three pound box of candy by the Secretary for the Association.

Action was taken by the Association showing their keen appreciation for the generous hospitality and the splendid reception given the Association by the University of Illinois and especially to Dean Mumford and the officers and members of the Agronomy Department.

Friday evening at 6 o'clock the members of the Agronomy Department entertained the delegates to the Conference at an elaborate banquet at the Inman Hotel. Dean Mumford was a guest of honor and Professor Burleson acted as toastmaster. Following the banquet the Association gave three cheers for the University of Illinois Department of Agronomy and all of its members in appreciation for the splendid banquet they gave.

Prior to the holding of the business meeting there were a number of committee reports which were read as a part of the regular program. Action was taken by the Association concerning these various reports and a record is hereby given of this business which was transacted.

Following the address by Professor Miller, Dr. Condra made a motion to the effect that the Association should urge that all original material, notes, etc., should be filed in a fire proof vault either in Washington or in the several states as seems best and thus permanently preserved for future use.

The report of the Committee on Color Standards which was read by J. G. Hutton was accepted. The Committee was thanked for their splendid work and they were asked to continue.

The report of the Committee on Publicity read by Dr. P. E. Brown was accepted.

In the absence of the chairman of the Committee on Legislation no report was presented.

The report of the Committee on the Improvement of Soil Maps and Reports read by W. J. Geib was accepted and action was taken favoring the splitting of this committee into two committees, one for the improvement of Soil Maps and the other for the improvement of Soil Reports.

The report of the Committee on Correlative Laboratory Work was read by G. W. Conrey. The report was accepted and the Committee continued.

The report of the Committee to consider the question of association with the Agronomy Society was read by Prof. M. F. Miller and accepted.

The report of the Committee on Organic Soils was read by Dr. F. J. Alway. The report was accepted and the Committee continued.

The Association went on record as being in favor of having an additional Committee on Terminology.

OFFICERS AND COMMITTEE ASSIGNMENTS FOR 1923.

OFFICERS:

Pres. - F. J. Alway
V.Pres. - M. M. McCool
Sec.-Treas. - A. M. O'Neal

COMMITTEES:

Color Standards:
- J. Gladdon Hutton
- Thos. D. Rice
- A. M. O'Neal

Information and Publicity:
- C. F. Shaw
- W. E. Hearn
- W. H. Stevenson

Legislation:
- G. E. Condra
- M. F. Miller
- P. E. Brown

Im provement in Soil Maps:
- W. J. Geib
- T. D. Rice
- J. O. Veatch

Improvement in Soil Survey Reports:
- P. E. Brown
- H. H. Kruseкopf
- A. T. Wiancko
- A. R. Whitson

Correlative Laboratory Work:
- G. W. Conrey
- M. M. McCool
- R. S. Smith
- Roy Hansen

Committee on Change of Name, Field of Association and Affiliation with Agronomy Society.

- M. F. Miller
- Robt. Harcourt
- C. F. Marbut
- R. S. Smith

Terminology
- C. F. Marbut
- G. E. Condra
- H. L. Walster

Classification of Organic Soils

H. H. Bennett
M. M. McCool
R. S. Smith
W. J. Geib
S. D. Conner
Chas. F. Shaw
C. B. Clevenger

MEMBERS AND FRIENDS OF THE AMERICAN ASSOCIATION OF SOIL SURVEY WORKERS ATTENDING THE 1922 CONFERENCE, URBANA, ILLINOIS.

1	F. J. Alway	St. Paul, Minn.
2	B. W. Tillman	Bellville, Ill.
3	H. H. Krusekopf	Columbia, Mo.
4	J. E. Adams	LaFayette, Ind.
5	W. E. Tharp	Washington, D. C.
6	E. W. Knobel	" "
7	Mrs. A. T. Sweet	Neosho, Mo.
8	A. T. Sweet	" "
9	H. G. Lewis	Ithaca, N. Y.
10	W. E. Hearn	Washington, D. C.
11	Thos. D. Rice	" "
12	H. H. Bennett	" "
13	A. T. Wiancko	LaFayette, Ind.
14	J. G. Hutton	Brookings, S. D.
15	A. E. Taylor	Findley, Ohio.
16	H. L. Walster	Agric. College, N. D.
17	T. H. Benton	Ames, Iowa.
18	H. V. Jordan	Columbia, Mo.
19	A. L. Patrick	State College, Pa.
20	C. F. Marbut	Washington, D. C.
21	G. W. Conrey	Columbia, Mo.
22	M. H. Lapham	Berkeley, Cal.
23	A. M. O'Neal	Ames, Iowa.
24	L. R. Schoenmann	Lansing, Mich.
25	C. Lounsbury	Washington, D. C.
26	P. R. McMiller	Minneapolis, Minn.
27	P. E. Brown	Ames, Iowa.
28	W. M. Senstius	Chicago, Ill.
29	E. C. Hall	105 W Monroe St., Chicago, Ill.
30	A. T. Higgins	Sullivan, Ill.
31	C. B. Manifold	Washington, D. C.
32	W. P. Hiltebrand	Urbana, Ill.
33	D. C. Wimer	" "
34	A. L. Price	Chicago, Ill.
35	E. H. Bailey	Madison, Wis.
36	A. R. Albert	" "
37	E. D. Fowler	Fairmont, Ind.
38	C. A. Stanton	Columbus, Ohio.
39	C. B. Clevenger	Winnepeg, Canada.
40	Wm. B. Cobb	Baton Rouge, La.
41	J. A. Elwell	Washington, D. C.
42	D. S. Gray	Ames, Iowa.
43	A. L. Gray	Washington, D. C.
44	M. F. Miller	Columbia, Mo.
45	J. O. Veatch	East Lansing, Mich.
46	Robt. Wildermuth	Bangor, Maine.
47	F. J. O'Connell	Lansing, Mich.
48	M. J. Edwards	Madison, Wis.
49	C. W. D. Parsons	Central Sci.Co., Chicago, Ill.
50	G. E. Condra	Lincoln, Neb.
51	H. S. Grindley	Urbana, Ill.

52 T. E. Richmond . . . . Urbana, Ill.
53 G. L. Fuller . . . . ; Theresa, N. Y.
54 W. T. Carter, Jr., ... Washington, D. C.
55 E. E. DeTurk . . . . Urbana, Ill.
56 F. C. Bauer . . . . " "
57 M. A. Hein . . . . " "
58 E. A. Norton . . . . " "
59 B. B. Clark . . . . " "
60 R. G. Crammond . . . . " "
61 W. H. Meyer . . . . " "
62 A. H. Sears . . . . " "
63 A. L. Lang . . . . " "
64 H. J. Snyder . . . . " "
65 R. P. Thomas . . . . " "
66 C. J. Badger . . . . " "
67 J. Lamb . . . . " "
68 A. U. Thor . . . . " "
69 H. G. M. Jacobson . . . . " "
70 W. B. Harland . . . . " "
71 C. A. Morrison . . . . " "
72 J. W. Coale. . . . . " "
73 M. I. Wolkoff. . . . . " "
74 M. M. McCool . . . . East Lansing, Mich.
75 W. H. Mumford. . . . . Urbana, Ill.
76 W. J. Geib . . . . Madison, Wis.
77 O. J. Ellis. . . . . " "
78 F. A. Wyatt .. . . .Univ. of Alberta, Edmonton, Alberta.
79 A. H. Hawkins . . . . Saskatoon, Saskatchewan.
80 R. Hansen . . . . " "
81 S. D. Averett. . . . . Ky.Ex.Sta.,Lexington,Ky.
82 W. L. Slate, Jr.,. . . . Conn.Exp.Sta. . New Haven, Conn.
83 Mrs. R. S. Smith . . . . Urbana, Ill.
84 Miss Sybil Nagle . . . . " "
85 J. P. Seaton . . . . LaFayette, Ind.
86 T. M. Bushnell . . . . " "
87 G. Thomason / / . . . . (Thomson Phosphate Co.)Chicago, Ill.
88 S. O. Perkins . . . . Washington, D. C.
89 A. C. Anderson . . . . " "
90 S. D. Conner . . . . Lafayette, Ind.
91 L. H. Smith . . . . Urbana, Ill.
92 F. H. Crane . . . . Champaign, Ill.
93 R. A. Scott . . . . " "
94 G. E. Hall . . . . Manhattan, Kan.
95 F. W. DeWolf . (State Geological Survey)Urbana, Ill.
96 C. H. Pathont (Champaign Co.Farm Adv.) " "
97 C. M. Linsley . . . . Kankakee, Ill
98 F. W. Gault . . . . Urbana, Ill.
99 L. E. Rust . . . . " "
100 M. J. Plice . . . . Purdue, Ind.
101 R. A. Smith . . . . Lansing, Mich.
102 A. C. Chapman. . . . . Urbana, Ill.

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